
Hazardous Waste Management Section

Hazardous Waste Introduction

What are the implications of hazardous waste generation and disposal and why do we have to worry about them? We are not the first generation to consider this question, nor will we be the last. The activities in the Hazardous Waste Section of A-Way With Waste are designed to promote awareness of issues surrounding hazardous waste generation and management so that the teacher and the student will develop a base of knowledge upon which to make sound decisions in response to the problems, thereby becoming part of the solutions.

The primary goals of the activities are:

- To promote an awareness of the problems our society faces due to past hazardous waste disposal practices.
- To promote an understanding of how government in the state of Washington is working to deal with the problems of hazardous waste management.
- To help students understand their role in the problem and to give students some positive ways they can be a part of the solution.

Hazardous wastes, those waste that pose a danger to human health and the environment, have received considerable attention in recent years as our indiscriminate disposal practices of the past come back to haunt us. It was assumed that we would always find some place to “get rid” of our waste or that technological advances would lead to solutions of the mounting problems. Today, past assumptions are overshadowed by the realities of contaminated drinking water, acidified lakes, smog alerts, and the threats of global warming. Increasing awareness of the problems associated with improper management of hazardous waste has prompted public officials and private citizens to

demand that regulation be implemented to manage hazardous waste disposal.

By the time we learned hazardous waste management was needed, we had already released millions of tons of dangerous chemicals into our water and air, and onto our land. Contaminated sites have been identified all across the state. One of the most notable is the contamination of our drinking water. Already, households throughout the state must use bottled water. In Spokane the sole source aquifer that provides drinking water is threatened by hazardous chemical contamination. There are 625 hazardous waste sites in Washington State.¹ Table 1 on p. 236 lists the sites that have been designated by EPA as Superfund Sites.

Hazardous wastes come in many different forms and pose a variety of health risks. Some chemicals are toxic if ingested, inhaled, and/or absorbed through the skin. The effects of exposure can take many different forms. Generally, hazards can be considered either chronic or acute. Acute hazards are those that cause harm immediately. Thus accidentally swallowing drain cleaner leads to an immediate life threatening situation, the danger depending upon the amount ingested. Chronic hazards are those that can cause harm through long-term, low level exposure. The health or environmental effects may take years to appear. Pesticides such as DDT and many industrial wastes fall into this category.

Assessing the risks to human health from exposure to the various chemical products and wastes in our environment is difficult. Much of our knowledge is not based on observation of human exposure but on studies of animal exposure. Often the chronic hazards and the combined effect of different chemicals are unknown.

¹ Washington State Department of Ecology, Model Toxics Control Act, 1995 Annual Report, 1995, p. 20.

Washington State Superfund Sites

There are currently 53 sites in Washington State.

Clark County	Alcoa (Vancouver Smelter) Boomsnub/BOC Gases BPA - Ross Complex* Frontier Hard Chrome Vancouver Water Station # 4	Vancouver Vancouver Vancouver Vancouver Vancouver
Franklin County	Pasco Sanitary Landfill	Pasco
Grant County	Moses Lake WF	Moses Lake
Island County	USN Whidbey	Oak Harbor
King County	Harbor Island Kent Highlands Landfill Midway Landfill PACCAR Queen City Farms (2 sites) Western Processing	Seattle Kent Kent Renton Maple Valley Kent
Kitsap County	Wyckoff	Bainbridge Island
Lewis County	American Crossarm and Conduit Company	Chehalis
Okanogan County	Silver Mountain Mine	Loomis
Pierce County	Asarco Commencement Bay Nearshore/Tideflats (11 sites) Fort Lewis (3 sites) Hidden Valley Landfill (Thun Field) Ponders Corner Ruston/North Tacoma South Tacoma Field Tacoma Tar Pits Well 12A	Tacoma Tacoma Fort Lewis Puyallup Lakewood Tacoma Tacoma Tacoma Tacoma
Snohomish County	Tulalip Landfill	Marysville
Spokane County	Geiger Electric Greenacres Landfill Kaiser Aluminum Mica Landfill North Market Street Northside Landfill Old Inland Pit Spokane Junk Yard	Spokane Greenacres Mead Mica Spokane Spokane Spokane Spokane
Whatcom County	Northwest Transformer (2 sites)	Everson
Yakima County	FMC Corporation	Yakima

*Denotes Federal Facility

Washington State Department of Ecology, Model Toxics Control Act, 1995 Annual Report, 1995, Publ. # 95-611.

Table 1

Identifying, investigating, and cleaning up contaminated sites to minimize exposure is a long, complicated, and expensive process. In some cases, responsible parties can be identified and are required to pay the cleanup cost. Often the cleanup cost must be funded by the state or by the federal Superfund program. It is, of course, more effective to change old habits and control the way waste is managed in the future than to clean up the mistakes of the past.

Essentially all of our activities generate waste and almost all wastes have some potential for hazard. In 1993, Washington's businesses released about 24.6 million pounds of toxic chemicals.² This amount represents the companies that have reported to Washington State Department of Ecology and includes releases to air, land, and water.

Many businesses, such as dry cleaners, printing shops and auto body shops, commonly generate hazardous waste but are not required to report to the Department because they generate under the threshold set by the Dangerous Waste Regulations (WAC 173-303). In order to avoid the reporting requirements, small quantity generators, as these businesses are known, must generate less than 220 pounds of hazardous waste per month and accumulate less than 2220 pounds prior to disposal. Some waste, called acutely hazardous waste, must be reported if generated in quantities as small as 2.2 pounds. Although not required by the Dangerous Waste Regulations to report, small quantity generators are required to dispose of their waste as outlined in the regulations. In 1994 Washington residents, not regulated by the Dangerous Waste Regulations, sent an estimated 11.8 million pounds of household hazardous waste to solid waste landfills and incinerators.³

1994 Hazardous Waste Generation⁴

Each year, all businesses in Washington that generate regulated quantities of hazardous waste are required to submit an Annual Dangerous Waste Report to the Department of Ecology. These reports are required under the state's Dangerous Waste Regulations. These reports are a detailed summary of the hazardous waste activity that occurred at each individual generation site. On the report, generators of hazardous waste give information as to the volume and types of hazardous waste they generated and how their waste was managed (either on-site or off-site) and its final destination.

The annual report data Ecology receives from generators serves as the basis for decision making throughout the Hazardous Waste Toxic Reduction Program. State planners use the data for projecting the state's future generation and management capacity needs. In the area of toxic reduction, the annual report data is used to assign hazardous waste generator fees which fund waste minimization technical assistance. In day to day program operations, such as regulatory development and enforcement action, the data is used to analyze waste activities.

The waste data reported to Ecology in the Annual Reports is analyzed in the following four primary categories of generation type:

- **Recurrent waste** is derived from a generator's on-going production process. This type of waste includes those that have been recycled and burned on-site.
- **Permit-by-Rule** waste waters are those waters discharged under National Pollution Discharge Elimination System (NPDES), state water quality, or local discharge permits that designate as dangerous waste prior to on-site treatment by the generator. In most cases, this waste type meets the definition of

2 Washington State Department of Ecology, Washington State Toxic Release Inventory, Summary Report: 1993, July 1995, Publ. # 95-417.

3 Ibid, Solid Waste in Washington State, Fourth Annual Status Report, Including the 1994 Recycling Survey, Feb. 1996, Publ. # 96-500.

4 Hazardous Waste updated information from Jean Rushing, Department of Ecology, Olympia, Washington.

Waste Generation (in tons)

COUNTY	NO. OF GENERATORS	RECURRENT	NON-RECURRENT	PERMIT-BY-RULE	MIXED RADIOACTIVE	TOTAL
ADAMS	19	4.33	12.13			16.46
ASOTIN	10	1.32	1.93			3.25
BENTON	126	682.78	3,471.13	18,152.89	119,744.32	142,051.12
CHELAN	89	2,419.79	77.86			2,497.65
CLALLAM	73	33.70	26.80	4.28		64.78
CLARK	250	12,513.64	317.72	274,281.66		287,113.02
COLUMBIA	11	2.31	5.56			7.87
COWLITZ	114	45,992.80	7.97			46,000.77
DOUGLAS	21	6.18	120.00			126.18
FERRY	7	5.06				5.06
FRANKLIN	75	1,193.13	9.64			1,202.77
GARFIELD	5	1.27				1.27
GRANT	97	143.54	1.87	100,305.37		100,450.78
GRAYS HARBOR	78	35.52	113.39			148.91
ISLAND	28	509.87	1.29			511.16
JEFFERSON	34	58.44	6.38			64.82
KING	2,686	69,827.14	10,742.99	1,495,961.14	8.52	1,586,539.79
KITSAP	195	8,890.10	25,957.42	15,488.19	9,202.55	59,538.26
KITTITAS	28	13.42				13.42
Klickitat	16	10,509.54				10,509.54
LEWIS	109	148.69	1,057.99	15,137.61		16,344.29
LINCOLN	16	0.13				0.13
MASON	37	25.01	2.37			27.38
OKANOGAN	45	37.32	3.87			41.19
PACIFIC	21	11.07	0.91			11.98
PEND OREILLE	9	1.69				1.69
Pierce	865	26,125.46	54,476.31	653,359.84		733,961.61
SAN JUAN	4	0.64	0.03			0.67
SKAGIT	122	19,014.19	812.43	3,600,000.00		3,619,826.62
SKAMANIA	6					—
SNOHOMISH	613	4,546.58	102.86	48,265.58		52,915.02
SPOKANE	482	4,116.76	610.87	21,465.40		26,193.03
STEVENS	25	9,908.34				9,908.34
THURSTON	214	338.66	7.73			346.39
WALLA WALLA	50	160.90	1.55			162.45
WHATCOM	185	7,636.85	138.70	321,000.00		328,775.55
WHITMAN	45	27.98	87.60	15.09	4.72	135.39
YAKIMA	215	356.56	95.76			452.32
TOTAL	7,025	225,300.71	98,273.06	6,563,437.05	128,960.11	7,015,970.93

“recurrent.” Due to the tremendous volume of waste waters generated by a small percentage of sites, this waste type is analyzed separately as not to overwhelm all other sources of waste.

- **Non-Recurrent** waste are those not normally associated with a site's ongoing operations. Demolition or clean-up debris, contaminated soils, or spill materials that are accidentally or infrequently generated are a few examples.

- **Radioactive Mixed** waste streams originate almost exclusively from the United States Department of Energy's Hanford Nuclear Reservation. These radioactive mixed waste streams consist of designated hazardous waste that exhibit low level radioactivity. High level radioactive waste is regulated by Ecology's Nuclear and Mixed Waste Program. In most cases, radioactive waste will meet the definition of either "recurrent" or "non-recurrent" wastes. Since this waste comes from only a few sources, combined with the large quantities generated, this waste type is analyzed separately as not to overwhelm all other wastes sources.

In 1994, Washington State generated just over 7 million tons of hazardous waste. Table 2 on p. 238 shows the volume of wastes generated and number of generators in each county. By looking at the table, it's easy to see a few of the relationships between counties and types of waste generated. For example, only three counties in Washington reported the generation of mixed radioactive waste. The US Department of Energy's Hanford Reservation, located in Benton county, is the primary generator of this waste stream followed by Puget Sound Naval shipyard in Kitsap county from the repair of nuclear powered ships and submarines. A few counties, such as Skagit and Whatcom, reported very large quantities of Permit-by-Rule waste waters. In this case, the large waste water volumes were generated by just a few petroleum refineries located. With recurrent waste, a strong correlation can be made between the counties with high urban density (such as King and Pierce) and the amount of recurrent waste generated there.

1994 Hazardous Waste Management

In 1994, 6,822,448 tons of hazardous waste were managed in Washington State by both commercial Treatment Storage Disposal Recycling facilities (TSDRs - businesses that specialize in the treating, storing, disposal and/or recycling of hazardous wastes) and captive facilities (those who either generate and manage their own waste on-site or receive waste from a select group of generators usually having the same ownership). Examples of commercial TSDRs in Washington State include Phillip Environmental, Safety Kleen and Sol-Pro. Examples of captive facilities include Boeing and the Federal Government's Defense Reutilization and Mobilization Organization (DRMO) at Fort Lewis.

For purposes of summarizing hazardous waste management, the Department of Ecology has defined and analyzed the following three primary categories of management type:

- **Treatment** means the physical, or biological processing of hazardous waste to make such waste non hazardous or less hazardous, safer for transport, amenable for energy or material resource recovery, or amenable for storage or reduced in volume.
- **Storage** means the holding of a hazardous waste for a temporary period.
- **Disposal** means the discharge, discarding or abandoning of hazardous waste, or the treatment, decontamination, or recycling of such wastes once they have been discarded or abandoned. This includes the discharge of hazardous waste into or on any land, air or water.

Waste Management - 1994 (in tons)

	TREATMENT	STORAGE	DISPOSAL	TOTAL
TOTAL	6,689,668	119,484	13,296	6,822,448

As you can see in the table on p. 238, the dominant waste management type is Permit-by-Rule. Waste waters account for nearly 97 percent of the waste managed within the state. In almost all cases, these waste waters are treated at the same site of generation. Following treatment, Permit-by-Rule waste waters are discharged to local sewers under special permits. Radioactive mixed waste accounted for less than 2 percent and was managed. These waste were generated and managed almost exclusively by the Department of Energy-Hanford. The Other category of waste is made up of waste types that did not classify as either Permit-by-Rule or Radioactive mixed. This accounts for 1 percent of the waste managed and includes both recurrent and non-recurrent waste types as defined by the individual generators.

Hazardous Waste Exports

Since Washington State does not have a hazardous waste landfill or incinerator, a large proportion of waste is exported out of state to specialized facilities in other states or countries. In 1994, 167,833 tons of hazardous waste were exported out of Washington for treatment, management and/or disposal elsewhere. Due to its close proximity and available hazardous waste landfill, the state of Oregon received 70 percent of this exported waste.

Hazardous Waste Fact Sheets

Hazardous Waste Management

Washington State Facts

In 1994, Washington State industries and commercial operations generated just over 7 million tons of hazardous waste. Source: Jean Rushing, Department of Ecology, Olympia, Washington.

In 1994, 6,689,668 tons of hazardous wastes were treated, 119,484 tons were stored and 13,296 tons were disposed. Source: Jean Rushing, Ecology.

Washington State does not have a final disposal facility for hazardous waste, such as a specially built landfill or high temperature incinerator. As a result, in 1994, 167,833 tons were sent out of state for final disposal. Source: Jean Rushing, Ecology.

In 1994, Washington residents sent about 11.8 million pounds of household hazardous waste to landfills and incinerators. Source: Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report, Including the 1994 Recycling Survey, Feb. 1996, Publ. # 96-500..

Hazardous Waste: Pesticides

International Facts

Many chemicals that have been banned or restricted by industrial countries are still widely used by farmers in the Third World. DDT and benzene hexachloride (BHC) are examples of chemicals banned from use in the U.S. and much of Europe, yet they account for about three-quarters of pesticide use in India. Source: Sandra Postel, "Defusing the Toxics Threat: Controlling Pesticides and Industrial Waste," Worldwatch Paper 79, Washington, D.C. Worldwatch Institute, 1987, p. 16.

Consumers in industrial countries are still exposed to these chemicals through imported foods, even though their own governments may have restricted or banned them from domestic use. Source: Postel, p. 16.

Although a monitoring program exists in the United States, the General Accounting Office (GAO) estimates that less than 1 percent of imported fruits and vegetables are inspected for banned pesticides. Source: Postel, p. 16.

U.S. Facts

U.S. pesticide facts source: Sandra Postel, "Defusing the Toxics Threat" Worldwatch Paper 79, Washington D.C.: Worldwatch Institute, 1987.

Pests have evolved mechanisms of detoxifying and resisting the action of chemicals designed to kill them. In fact, chemicals have killed natural enemies that help control the pest population. Therefore, chemicals no longer provide the effective means of crop protection they once did. In 1938, scientists knew of just seven insect and mite species that had acquired resistance to pesticides. By 1984, 447 species, including most of the world's major pests, had acquired resistance of pesticides. Source: Postel, p. 19.

Integrated Pest Management (IPM) is an alternative approach to using pesticides as a corrective means of pest control and instead focuses on prevention as a strategy to reduce pesticide use. Source: Postel, p. 26.

IPM looks at the ecosystem as a whole, utilizing biological controls (e.g., natural predators), cultural practices (e.g., planting patterns), genetic manipulations (e.g., pest resistant crop varieties), and use of chemicals selectively and only when necessary. Source: Postel, p. 26.

Nearly 40 crops and collectively 11 million hectares, about 8 percent of the nation's harvested cropland area, have been utilizing IPM programs since 1984. Source: Postel, p.29.

Waste Reduction Information

Reducing waste at the source, rather than having to properly manage it, can save resources, and save money. If reducing or reusing a waste is not possible, recycling is the next best option. Consider the following:

It takes 42 gallons of crude oil to produce 2 1/2 quarts of new lubricating oil. But just one gallon of used oil can be re-refined into the same high quality 2 1/2 quarts of lubricating oil. Source: Washington State Department of Ecology, The Used Oil Problem (pamphlet), Olympia: Waste Reduction, Recycling and Litter Control Program, 1990.

Recycling used crude oil could reduce national petroleum imports by 25.5 million barrels of oil per year, and save much of the energy to process it. Source: The Used Oil Problem.

One manufacturing facility in Southwest Washington found that they could recover methylene chloride, formerly handled as a hazardous waste, and sell it to a local solvent supplier for reuse in the paint industry. Now, each drum of methylene chloride recovered brings in revenue rather than costing money for disposal. Source: Success Through Waste Reduction, Volume II, 1992.

Benefits aren't just realized in direct costs savings either. Reduced regulatory burden, increases in production efficiency and improved competitiveness and improved worker safety are all benefits that facilities have experienced through reducing their use of hazardous chemicals. For example, the owner of a wood products manufacturing facility found that his waste reduction program cut worker exposure to paints and solvent vapors. He discovered that a cleaner, safer workplace brought a decrease in worker absenteeism and injury and an increase in production rates and quality. These

changes have provided an economic edge over his competitors. Source: Success Through Waste Reduction, Volume II, 1992.

Using technologies and methods now available, pesticide use could probably be reduced by 50 percent and reduce the generation of industrial waste by a third or more over the next decade. Efforts to date suggest that farmers and manufacturers would benefit economically, while people and the environment would benefit through decreased risk. Source: Postel, p. 6

Hazardous Waste Cleanup

Washington State Facts

The Washington State Legislature passed the Hazardous Waste Cleanup Act (Ch. 70.105b RCW) in October 1987. It created a program that will help this state clean up and manage its solid and hazardous waste. In November 1988, Washington voters enacted Initiative 97, the Model Toxics Control Act, which became effective March 1, 1989, and replaces the Hazardous Waste Cleanup Act. Programs defined in Initiative 97 are funded by a tax on hazardous substances. Source: Washington State Department of Ecology, Hazardous Waste Cleanup Program: 1988 Annual Report, Olympia, 1989, p. 5.

It is estimated that there are about 625 hazardous waste sites in Washington State. Source: Washington State Department of Ecology, Model Toxics Control Act, 1995 Annual Report, p. 20.

In 1995 more than 816 spills of oil or hazardous substances demanded the State Department of Ecology's quick response. Source: 1995 Annual Report, p. 16.

Bikes And By-products

Subjects: Science, Social Studies

Grades: 3-8

Teaching Time: One Class Period

Focus: Hazardous Waste, Natural Resources, Manufacturing By-Products



Rationale

Sometimes making the things we do want creates things we don't want, such as hazardous waste.

Learning Objective

Students will:

- Learn what the term "hazardous waste" means.
- Learn some of the hazardous wastes created by the manufacturing of a bicycle.

Materials

- Bicycle (select a student to bring one to class)
- Diagram "Bicycle Materials, Wastes, and By-products"

Pre & Post Test Questions

1. What raw material is plastic and synthetic rubber made from?
2. What happens to hazardous industrial wastes?
3. (Grades 3-4) What is a natural resource? Name two.

Learning Procedure

1 Ask: "How many of you have bicycles?" "Of what are they made?" "What are the frames made of?" "How about the tires?" "The handle bar grips?" "Where are the metal and rubber and plastic that go into bicycles made?" (In mills and factories that transform raw materials such as petroleum, bauxite, and iron ore into bicycle

components.) **Ask:** "What makes your bike special - different from others?" "How many different colors of bikes do we have?" "Whose bike is shiny?" "What is the shiny metal on bikes called?" **Ask:** "Which natural resources are used in the making of bikes?" (iron and petroleum for plastics, synthetic fibers, and synthetic rubber; petroleum distillates for paint and paint solvents; bauxite for aluminum; chrome, coal for coke to smelt the iron ore into steel; and others.) **Ask:** "What had to happen to the natural resources before they could be used to build your bike?" (They had to be processed in factories.) Direct the discussion from here with the aim of having students realize that when natural raw materials are processed, by-products and waste, some of which may be harmful, are produced. **Ask:** "What are by-products?" "For example, what by-products are produced when you burn wood and paper in your fireplace or woodstove at home?" "Are some of these by-products harmful?" "What kinds of things might be by-products of the manufacturing of your bicycle?"

2 Distribute: "Bicycle Materials, Wastes, and By-products" (A diagram of a bicycle that lists some of the materials and by-products associated

with the manufacturing of bikes) or ask a student to bring his or her bike to class. In the latter case, have students make their own diagrams of the bike. Guide students in identifying the bike's component materials (steel, synthetic rubber, plastic, chrome, synthetic fibers, aluminum, paint, etc.). Then, by referring to the diagram, point out some of the by-products and wastes resulting from the manufacturing of these components.

3 Explain: Some of the by-products and wastes from making a bike are hazardous. Discuss what hazardous means. NOTE: Hazardous means dangerous. Hazardous wastes are likely to cause harm to the environment or humans because they are either toxic (poisonous), flammable (ignitable, highly burnable), reactive (explosive), or corrosive (substances that rapidly eat into and/or dissolve what they touch).

Ask: "Does this mean that you will get sick from handling or riding your bike?" "Why not?" "What happened to the hazardous by-products and wastes

produced when your bike was made?" (NOTE: Some are captured and recycled for industrial reuse. Some are captured and disposed of in hazardous waste disposal sites, such as the one in Arlington, Oregon. Some escape into the air and water, such as into Tacoma's Commencement Bay. Some are dumped illegally.)

Ask: "How should hazardous wastes and by-products be managed?" "Why is it important to use great care in disposing of these wastes and by-products?"

Ask: "Because hazardous wastes and by-products are made when bikes are built, should we stop making bikes?" "What should we do that makes more sense?" "What are some other things you use that might also have produced hazardous by-products when they were made?"

4 Discuss why there has been so much news about hazardous waste lately.

Acknowledgment

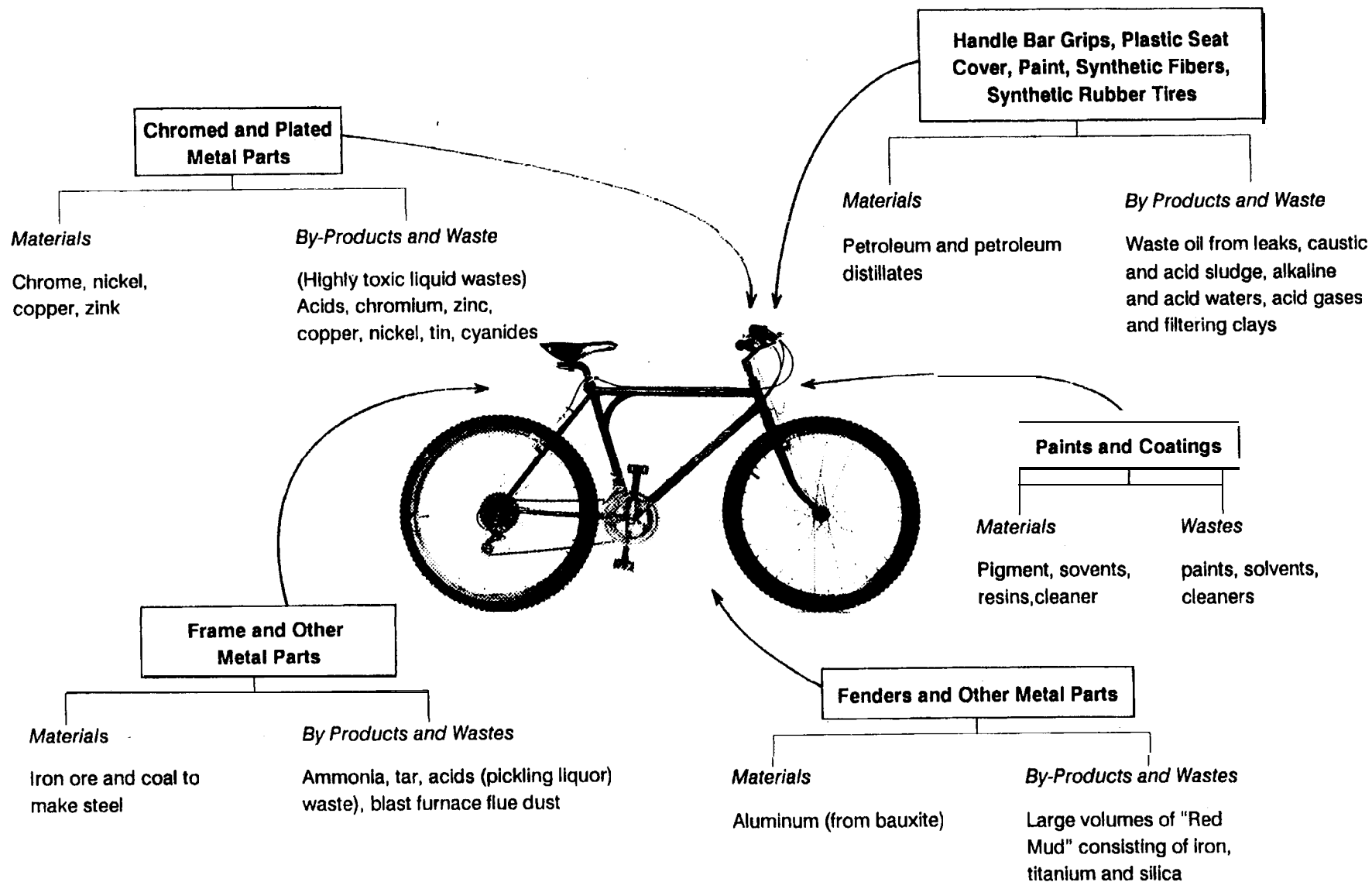
Special thanks to John Conroy, Washington State Department of Ecology, for help with this activity.

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Bicycle Materials, Wastes, and By-Products



Hazardous Waste in My Home Town?

Subjects: Social Studies: Geography, Economics, Environmental Studies

Grades: 7-12

Teaching Time: This Activity Can Be Spread Over One to Four Class Periods

Focus: Hazardous Waste Generation, Hazardous Substances, Community Right to Know

Rationale

Hazardous waste is produced in almost every community in Washington. Industry, government, and citizens share responsibility for managing hazardous waste. To deal with this complex and controversial issue, we need informed citizens.

Learning Objective

Students will:

- Identify the number and kinds of local commercial and industrial waste generators.
- Identify ways they benefit from products or services that produce hazardous waste.
- Learn where they can get information about hazardous waste.

Teacher Background

All businesses, large and small, generate waste. Some of this waste is hazardous. The toxic wastes produced by large firms in the chemical, pulp and paper, and steel and aluminum industries are obvious, but many small businesses that are found in every community also generate hazardous wastes. These include such operations as auto body repair shops and dry cleaners. "High-tech" companies that manufacture computer chips and electronic circuits are often thought of as "clean" industries. However, they, too, produce sometimes large quantities of hazardous by-products.

Materials

Teacher/Classroom materials

- Local telephone yellow pages
- Washington Manufacturers Guide (Available in most public libraries. Call the Department of Ecology Hazardous Substance Hotline - 1-800-633-7585. If you can't locate a copy; the Hotline will send you information about your county.)
- Overhead: "Hazardous Substance Characteristics," p. 299
- Overhead or handout: "Some Industrial and Commercial Hazardous Waste Categories" (Answer key)
- EPA brochure Protecting Our Ground Water (See Bibliography)

Student materials

- Map of your community or county—contact the city or county planning office (optional)
- Handout: "Businesses Generating Hazardous Waste"
- Handout: "Some Industrial and Commercial Hazardous Waste Categories" (blank worksheet)
- "It's Your Right to Know" pamphlet available from the Hazardous Substance Hotline 1-800-633-7585 (optional)

Pre & Post Test Questions

1. What characteristics make waste hazardous?
2. What are three types of small businesses that generate hazardous waste?
3. From whom can you learn more about hazardous waste?
4. Why are heavy metals hazardous?

Learning Procedure

1 Ask students to think of as many different kinds of businesses and industries in their area as possible. Use the yellow pages, the Washington Manufacturers Guide, or ask your Chamber of Commerce for information. Make sure that both large and small businesses are included. As local businesses and industries are identified, have students describe what products or services these enterprises provide. Tabulate the number and kind of industries on the board.

Discuss how these products or services benefit us. (For example: dry cleaners clean our sweaters, suits; automotive body shops repair or customize our cars; printing shops prepare brochures, flyers, newspapers, etc. that keep us informed.)

2 Ask: “What wastes might be produced by these local businesses and industries?” “How are these wastes managed?” (They’re either recycled, go to a landfill, or are released into the sewage system for treatment. If they are hazardous, they may be reused, recycled, stored, treated, or disposed of by way of a hazardous waste landfill or incinerator.)

3 Ask: “What qualities might be characteristic of a hazardous waste?” Show and discuss the overhead “Hazardous Substance Characteristics,” p. 299, so that students understand the five basic characteristics of hazardous waste.

Ask: “Under what conditions can a hazardous waste pose a threat to human or animal life?” (For example: persistent substances lasting a long time in the environment before being broken down into something less hazardous; long-term exposure to certain substances at low levels; bioaccumulation of substances; reactive or synergistic effects [See the Glossary for definition of terms]; heightened sensitivity of certain groups of people to specific substances, such as young children to lead, a heavy metal.)

4 Distribute copies of the handout “Businesses Generating Hazardous Waste.” **Ask:** “Did we find any of these kinds of businesses in our community?”

5 Pass out copies of the blank “Some Industrial and Commercial Hazardous Waste Categories” sheet. Ask students to match the categories with the hazard characteristics discussed above, by filling in the “blank” column. Explain that any category may have more than one characteristic, be persistent, or affect certain subgroups of people. Ask students to think of ways wastes might cause harm. This can be done individually or in groups using brainstorming techniques. Give students ten minutes or so to work on their answers. Using the “Some Industrial and Commercial Hazardous Waste Categories” answer key, go over students’ answers. **Ask:** “How can we find out more about the hazardous wastes generated in our community?”

6 Identify the Department of Ecology’s Hazardous Substance Hotline as a good source of information about hazardous substances and hazardous waste. Local city and county offices of water quality and environmental health often have specific information on small businesses producing hazardous waste. Tell students that a hazardous product is termed a hazardous waste when it is no longer wanted or useful and is destined for disposal. While the product is still considered useful, it is termed a hazardous substance.

If you wish, pass out “Your Right to Know” pamphlets. Explain to the students that although you have focused on hazardous waste and its potential for harm when disposed of, it is important to recognize that chemical substances pose potential danger during use and when they are stored prior to use — in other words, prior to their becoming hazardous waste. Discuss the principle that all citizens have a right to know about hazardous substances in their community.

7 Distribute the brochure “Protecting Our Ground Water.” **Ask:** “What are some of the ways wastes can enter the environment?”

Distribute maps of your town or county, or have students draw maps. Have students locate and mark the local landfill and sewage treatment plant. Have them highlight streams, lakes, and salt water. Discuss the significance of these locations.

Ask: “Is hazardous waste generated near any of these sensitive areas?” “Have we identified all the hazardous waste generators in our area?” “How can we find out?” “How can we get more information about hazardous waste?” Remind students that the Hazardous Substance Hotline has information on all these topics.

8 Using the list of businesses, have students mark the locations where hazardous wastes might be produced on their maps. When maps are complete, **Ask:** “Which areas in our town or county are most vulnerable or sensitive to pollution?” (Aquifers and wetlands, for example)

9 Ask: “What can we do to prevent pollution?” “How can we ensure that our environment and human or animal health is not endangered due to hazardous wastes in our communities?” Explain to students that to protect public health and the environment, hazardous waste is managed by a system much stricter than for nonhazardous waste.

Explain that the Department of Ecology is responsible for regulating hazardous waste and that one part of this responsibility is the monitoring of businesses that produce hazardous waste. But, local governments are responsible for small quantity generators—those producing less than 220 pounds (about 27 gallons, or half of a 55 gallon drum) of hazardous waste per month. (To introduce students to the career opportunities in environmental protection, do the activity “Investigating Environmental Professions,” p. 279.)

Extended Learning

1 Have students call the Hazardous Substance Hotline with questions about the wastes that may be generated or the hazardous substances stored in their community. Have them ask for a free brochure describing their right to know about hazardous substances.

2 Assign a particular waste to a group of students to research. For example, a group (or individual) might try to find out what are the specific hazards associated with the wastes generated by auto detailing shops, print shops, or dry cleaners.

3 Have students investigate the hazardous wastes generated by the school in chemistry labs and shop classes.

4 Check with local county government to find out what programs exist in your community for small business hazardous waste.

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Businesses Generating Hazardous Wastes

Type of Business	Hazardous Wastes Generated
Auto Repair and Maintenance	Lead-Acid Batteries Heavy Metals Solvents Acids/Bases Used Oils
Building Cleaning and Maintenance	Acids/Bases Solvents
Cleaning Agents and Cosmetics	Acid/Bases Heavy Metal/Inorganics Solvents
Construction	Acids/Bases Solvents Preserving Agents
Electric and Computer Chip Manufacturers	Acids/Bases Spent Plating Wastes
Farmers and Agricultural Service Shops	Pesticides Solvents Used Oils
Furniture/Wood Manufacturing/ Refinishing	Solvents
Laundries and Dry Cleaners	Dry Cleaning Filtration Residues Solvents
Motor Freight Terminals and Rail Transport	Acids/Bases Lead-Acid Batteries Heavy Metals/Inorganics Solvents Used Oils
Printing Industries	Acids/Bases Heavy Metals/Inorganics Ink Sludges Spent Plating Wastes
Schools, Labs, and Vocational Shops	Acids/Bases Solvents Heavy Metals/Inorganics
Wood Working (Boat builders, lumber mills, etc.)	Preserving Agents

Some Industrial and Commercial Hazardous Waste Categories - Answer Key

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases	Corrosive, Reactive	Can sometimes react violently with water
Cyanide Wastes	Toxic	
Filtration Residues	Corrosive, Reactive, Toxic	
Formaldehyde	Toxic	Sensitive populations - (1)
Heavy Metals and Inorganics	Toxic	Persistent; sensitive populations - (2)
Ink Sludges	Toxic	Persistent; sensitive populations - (2)
Oils (used)	Toxic	Persistent; sensitive populations
Pesticides	Toxic	Persistent - (3)
Preserving Agents	Toxic, Corrosive	
Solvents/ Degreasers	Corrosive, Reactive, Ignitable, Toxic	Sensitive populations - (1)
Spent Plating Wastes	Corrosive, Toxic	

-
1. Some individuals are especially sensitive.
 2. Children are especially at risk to lead exposure.
 3. Chlorinated pesticides can bioaccumulate.

Some Industrial & Commercial Hazardous Waste Categories - Worksheet

Waste Category	Hazard Characteristic(s)	Other Considerations
Acids/Bases		
Cyanide Wastes		
Filtration Residues		
Formaldehyde		
Heavy Metals and Inorganics		
Ink Sludges		
Oils (used)		
Pesticides		
Preserving Agents		
Solvents/ Degreasers		
Spent Plating Wastes		

What Waste Went Where?

Subjects: Social Studies: Washington State History, Contemporary Problems, Biology, Chemistry, Geography, Health and Safety

Grades: 9 -12

Teaching Time: One to Three Class Sessions

Focus: Hazardous Waste Management, Environmental Contamination, Health and Environmental Threats, Group Cooperation

Rationale

Unsafe and illegal handling of hazardous wastes has created many health and environmental problems in the state of Washington.

Learning Objective

Students will:

- Use information about Washington State to identify where, why, and which hazardous wastes have created environmental and health problems in our state.
- Work cooperatively to solve problems.

Teacher Background

There are hundreds of locations in Washington State where hazardous wastes have contaminated the environment. Some of these hazardous wastes continue to threaten the health of humans and wildlife. Others have been treated or removed.

This activity is designed to give students the “facts” about 14 of the hundreds of sites where hazardous wastes have been unsafely disposed of or spilled. Working cooperatively, groups of students will piece together the various “clues” about where, how, and what hazardous wastes have entered the environment in Washington.

Read the “What Waste Went Where” direction sheet that explains how the members of each group work together. In the “full” version of this activity, students identify 14 locations throughout the state. Shortened versions of the “game” can be “played” by using only three, six, or eight locations out of the fourteen.

Please see the items listed below under Teacher Resource and Background Materials for detailed information on the locations and hazardous substances described in this activity.

Materials

Game Materials

Each student group should have its own copies of the following:

- “What Waste Went Where” directions
- Map(s) of Washington State with numbered locations
- Clue cards—in the full game, there are 14 WHERE cards; 14 CONNECTION cards; 14 WHAT cards; and 6 FOLLOW-UP cards. Separate and shuffle the cards prior to starting the activity. (Shorter versions may have fewer cards.)
- Number line—for placing clue cards when the hazardous waste in that location is identified. Use the template provided or prepare your own.
- “What Waste Went Where” worksheet (optional)
- Group Evaluation Sheet

Teacher Resource and Background Materials

- “A Sampling of Locations in Washington Where Hazardous Wastes Have Entered the Environment”
- “Selected Hazardous Wastes - Their Health or Environmental Effects”
- Answer Key for worksheet, pp. 265-267

Participants Reference Materials

These items should be available to students for consultation.

- Road map of Washington
- Dictionary

Pre & Post Test Questions

1. Can you list at least six ways that hazardous substances get into the environment?
2. Can you list at least six problems that have been caused by hazardous substances being released into the environment?
3. Can you explain why the Department of Ecology and the Environmental Protection Agency must know exactly what hazardous substances are involved before they attempt to clean up a hazardous waste location?
4. What human activities contribute to the hazardous waste problem?

Learning Procedure

1 Introduce this activity by telling students that, in 1993 about 24.6 million pounds of toxic chemicals were released by industry in Washington State.¹ Many of these hazardous wastes are by-products from the manufacture of consumer products ranging from aluminum soda pop cans to chrome plated automobile ornaments.

Explain that the unsafe handling, storage, and disposal of hazardous wastes have caused serious problems in this country and in our state.

2 Start the “game” by dividing students into groups of three. The activity will progress faster if at least one member of each group is good at solving puzzles. Explain that this is a cooperative activity. Members in each group will work together to figure out what waste went where.

3 Pass out a copy of one or both of the maps of Washington to each of the groups. Tell students that the circles on the maps represent some of the many

hundreds of places in Washington where hazardous waste has escaped into the environment.

4 Point out the numbered locations marked on the map(s). Pass out the clue cards and tell students that each type of clue card (WHERE, WHAT, CONNECTION, AND FOLLOW-UP) contains certain key words and phrases that link them to a specific numbered location or to another card. Together, the cards contain all the clues needed to help group members figure out one hazardous waste that got into the environment in these particular locations.

5 Hand out and go over the directions with the students. Note that the WHERE cards are placed first. Tell students to use a road map if necessary. After the WHERE cards have been placed under the numbers, the CONNECTION cards are next, followed by the WHAT cards. The FOLLOW-UP cards are played last.

6 Circulate among the groups as they proceed, to make sure that each group is focusing on the proper key words and phrases in the cards. If necessary tell them when their cards are improperly placed, so they can see how the key words link up the different WHERE, CONNECTION, and WHAT cards to a given location. (Teacher: Refer to the answer key as you circulate.) Continue until all groups have matched the hazardous wastes to the numbered locations or until sufficient matches have been made to accomplish the learning objectives.

7 Depending on the problem-solving abilities of the students involved, the activity using all 14 locations could take two to three class periods to complete. If necessary use the “What Waste Went Where” worksheet to record each day’s results. The following steps outline several ways to shorten the activity.

¹ Washington State Department of Ecology, Washington State Toxic Release Inventory, Summary Report: 1993, July 1995.

One Period Version

With the class, go through the WHERE cards together. Then tell the groups the answers for the CONNECTION cards. Let the groups complete the matching on their own with the WHAT and FOLLOW-UP cards.

One or Two Period Versions

Prior to class, use the answer key to separate the cards that go with the first six and the last eight locations. Hand out either one or the other of these subgroups and the appropriate number line sections.

Tell students they are going to examine either Puget Sound (locations 1-6) or the state outside of Puget Sound (locations 7- 14). Proceed as in Step 6. Do one area the first day and the other area the next.

8 After all the groups have finished you may wish to hand out the answer key and any other teacher material as needed. Generate class discussion by asking the following questions:

- What actions of group members were most helpful in solving the puzzle and completing the activity?
- What did you learn about hazardous waste in Washington?
- How could the hazardous waste problems described in this game have been prevented? (government regulation of waste treatment, storage, and disposal; development of

alternate manufacturing processes; changing consumer habits; waste exchanges and recycling, etc.)

Extended Learning

1 When the groups have completed the matching part of the activity, give each group the "Evaluation of Group Participation," p. 278. This evaluation may be changed to meet the teacher's group interaction objectives.

2 Show the overhead "Hazardous Substance Characteristics," on p. 299. Ask students to identify the hazard characteristics that some or all of the chemicals in this activity have.

3 Have students identify and research a hazardous waste location near where they live by calling a hazardous waste inspector at the nearest Department of Ecology office or the Hazardous Substance Information Hotline 1-800-633-7585. (Teacher, please call in advance to prepare the Department and the Hotline for calls.)

4 Have students find out what was done or is being done at this site to reduce damage to human health and the environment.

5 Have students research what has been done to clean up hazardous wastes at the locations described in this activity.

Acknowledgment

Honors to Mary Porter for many hours spent developing, writing, and field-testing this activity. The following people in the Washington State Department of Ecology very kindly took the time to provide detailed information about each of the hazardous waste sites used in this activity: Dennis Bowhay, Yakima; Lynn Bernstein, Olympia; John Conroy, Redmond; Jim Malm, Spokane.

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A Sampling Of Locations In Washington Where Hazardous Wastes Have Entered The Environment

This is background information for the teacher. Do not share this information with students until they have completed the “What Waste Went Where” activity.

There are hundreds of locations in Washington State where hazardous wastes have entered the environment from manufacturing, storage, or spills. The following is a sampling to show a range of hazardous waste locations around the state and reasons the hazardous wastes are there.

1. Purdy Junkyard Site, Kitsap County

Eight Northwest public utilities stored electrical transformers in a junkyard in Purdy, south of Bremerton. The transformer cooling oil contained polychlorinated biphenyls - PCBs. In the process of salvaging the copper wire in the transformers, PCBs drained onto and contaminated the soil. Rainwater carried the hazardous chemicals toward a saltwater lagoon downhill from the junkyard. Organisms in the lagoon now have PCBs in their systems.

In addition, some of the PCB-contaminated transformer oil was used for dust suppression and some was burned. When PCBs burn, another extremely hazardous chemical forms. This chemical is 2,3,7,8-TCDD, the most toxic form of dioxin.

The junkyard owner voluntarily assisted in the site's cleanup.

2. Western Processing, King County

This chemical processing and storage plant operated in Kent from 1960 to 1983. Western Processing accepted hazardous wastes from over 300 companies, including Boeing and other industrial manufacturers.

The wastes, however, were not properly managed. About 100 chemicals with proven levels of toxicity have contaminated soil at the site and are threatening ground water and nearby Mill Creek.

Nitrobenzene is one of the hazardous chemicals that leaked from drums at Western Processing. Others include the most toxic form of dioxin - 2,3,7,8- TCDD, which was found in 2,500 gallons of kerosene at levels of 200-300 parts per million (ppm) and dichloroethylene, a solvent that leached into the ground water.

Some of the hazardous wastes may be entering an aquifer that was to be a future source of drinking water for the city of Kent.

3. Midway Landfill, King County

Located between Seattle and Tacoma, this landfill was opened in the 1960s to receive demolition debris from road construction. The landfill, operated by the City of Seattle, was sited in a gravel pit surrounded by wetlands. The people living near the site were strongly opposed to the location of the landfill but were promised it would handle harmless wastes.

All kinds of wastes, however, were dumped. Over 20 years, the decomposing garbage produced large volumes of methane gas. This gas, which is explosive when mixed at 5 to 13 percent concentration with air,² migrated in some directions over a quarter of a mile through the porous, gravelly soils, finally moving into the basements of homes and businesses.

Eleven families were evacuated because of the potential danger of explosion and because other landfill gases also threatened health.

Benzene, vinyl chloride, and hydrogen sulfide

2 Douglas M. Considine and Glenn D. Considine, Van Nostrand Reinhold Encyclopedia of Chemistry, New York, N.Y.: Van Nostrand Reinhold Company, Inc., 1984, p. 570.

produced by the landfill have also contaminated ground water.

“For Sale” signs were everywhere in nearby neighborhoods. The City of Seattle has purchased 122 houses and has spent nearly \$100 million on this landfill and another nearby dump at Kent Highlands.³ Seattle now has one of the highest garbage disposal rates in the country and this enormously expensive remediation is a major contributing factor.

4. ASARCO Copper Smelter, Tacoma, Pierce County

This copper smelter near Commencement Bay in Tacoma closed down in 1985. During the years of its operation, arsenic, cadmium, lead, and impurities removed from the copper ore were spread for miles by the lift of hot gases from the smelter stack. Heavy metal-contaminated smelter slag ended up in building foundations all over Tacoma.

Studies with honey bees in the Puget Sound region have revealed the wide extent of the arsenic and cadmium pollution and have shown that these metals contributed to bee mortality. In addition, gardeners in parts of Vashon Island downwind of the smelter were advised not to eat their homegrown vegetables.

The dismantlement of the smelter is now largely complete. The U.S. Environmental Protection Agency has designated the smelter grounds as a hazardous waste Superfund site. The Washington State Department of Ecology hazardous waste staff estimate that complete cleanup could take 20 years.

5. Buffalo Don Murphy Junkyard, Pierce County

During the 1970s, Buffalo Don Murphy stored waste from Reichold Chemical Company on his five-acre rural property. Over 1000 drums of different wastes generated in the manufacture of industrial disinfectants were stored at the junkyard. Hazardous compounds such as pentachlorophenol

(a wood preservative), phenanthrene, and anthracene (by-products of the burning of carbon compounds) leaked out of these drums and into the soil.

The property is a filled wetland and is near a creek used for irrigation and stock watering. Several schools are nearby.

Some of the wastes were sold as wood preservatives and weed killers.

Buffalo Don died in 1975.

6. Strawberry farm, Thurston County

A pesticide, Terr-o-cide, which is 54 percent EDB (ethylene dibromide, a now illegal compound) was applied for three years at the rate of 18-20 gallons per acre on this 12-acre farm near Olympia.

EDB and DCP(1,2-dichloropropane), a chemical used to kill nematodes, polluted nearby wells that provided water for 22 homes. The residents were drinking bottled water until a new source of clean water could be provided.

7. Weyerhaeuser Company Chloralkali Plant, Cowlitz County

From 1956 to 1975, this plant in Longview used a mercury process to produce chlorine gas and caustic soda for an adjacent pulp mill. The waste mercury and zinc have contaminated soils and ground water at the site and, possibly, sediments and resident fish in the Columbia River.

8. Frontier Hard Chrome, Clark County

This chromeplating company operated from 1970 to 1983 in Vancouver, half a mile north of the Columbia River. The waste hexavalent chromium was discharged into a dry well and has entered ground water. A study shows that the contaminated ground water is flowing toward the Columbia River.

3 David Schaefer, “City, Homeowners Settle in Suit over Landfill,” Seattle Times, April 20, 1988.

9. Train derailment, Klickitat County

Many train derailments have spilled hazardous materials ranging from sodium hydroxide to oil. A derailment near White Salmon spilled antifreeze and hydraulic fluid on the banks of the Columbia River.

10. Jet fighter emergency landing, Yakima County

In 1983, a jet fighter was forced by a malfunction to land at Yakima airport. Hydrazine, an extremely reactive and toxic fuel used in the jet's backup generator system, leaked onto the ground. Airport workers wanted to clean up the spill, but the Department of Ecology secured the area and a spill response team from McChord Air Force Base, wearing protective suits and breathing gear, removed the fuel.

11. Crop King Chemical, Yakima County

This company in Yakima manufactured and formulated pesticides between 1940 and 1985. Leftover pesticides, including DDT, have contaminated soil and possibly ground water at the site.

12. Turner Dump Site, Okanogan County

An individual who was moving cleaned all the stored pesticides out of a shed at his place south of Okanogan and dumped them on the bank of the Okanogan River. A neighbor alerted the Department of Ecology and an emergency cleanup was conducted. Among the discarded pesticides were: 14 gallons of parathion, 13 pounds of lindane, 50 pounds of strychnine, and 2 gallons of endrin. (Because of the risks they pose to public health and the environment, endrin is now illegal in Washington State, and the use of parathion and lindane is restricted. Endrin and lindane are no longer being manufactured. The trend is to not manufacture these persistent chlorinated hydrocarbons for use as pesticides.)⁴

A total of 24 identifiable pesticides were recovered. It took six people three days, working 16 hours a day to

collect 25 drums of hazardous waste from the riverbank.

The individual was indicted for endangering public health, but a jury in Spokane cleared him because they thought his actions did not make him a criminal.

13. Colbert Landfill, Spokane County

This landfill, eight miles north of Spokane, was operated by the Spokane County Utilities Department from 1968 until 1986. Between 1975 and 1980 Key Tronic Corporation dumped tons of chemical solvents into the landfill. Three of the hazardous chemicals were—1,1-dichloroethane, 1,1-dichloroethylene, and 1,1,1-trichloroethane.⁵

The chemicals seeped into the ground water and contaminated the wells of families living nearby. Their well water contained levels of 1,1,1-trichloroethane up to ten times the levels considered safe. The plume of contamination is spreading south and west in the aquifer under the landfill.

14. North Market Street, Spokane County

Petroleum by-products have contaminated the wells in an area a mile north of Spokane. Discovered in 1984, a huge underground pool of petroleum waste containing benzene, toluene, and xylene caused problems for a nursery watering its trees from a well. The chain-link fence and paving around the nursery turned oily brown, and \$10,000 worth of maples, spruces, and other trees died. The nursery had to be moved.

The hazardous petroleum by-products are slowly leaching and spreading in the Spokane aquifer.⁶

The area has a long history of use as a site for oil refineries, tank farms, pipeline terminals, and retail oil sales outlets. At one location, waste oil was pumped into unlined lagoons that may have been as large as four acres. There have been 16 potentially responsible parties identified.

4 Mary Touhy, Department of Agriculture.

5 Jeff Sher, "Trichloroethane in Our Water," Spokesman Review, May 14, 1982.

6 Lonnie Rosenwald, "\$500 Million Sought for Cleanup," Spokesman Review, November 10, 1985. Jeff Sher, "Pollution Spreading in Aquifers," Spokesman Review, December 22, 1985.

Selected Hazardous Chemicals And Compounds – Their Characteristics And Health Or Environmental Effects

Please note: The health effects of intense, acute exposure and low-level, long-term exposure to hazardous material are not the same. In some cases the effects of chronic, low-level exposure are not known.

Hazardous Material	Characteristic	Health or Environmental Effects
Arsenic	Gray solid. Water insoluble. Highly toxic if ingested or inhaled.	Birth defects in animals after long-term exposure. Skin and lung cancer in humans.
Benzene	Colorless liquid slightly water soluble. Very ignitable. Highly toxic if ingested, inhaled, or if in contact with skin.	Interferes with red and white blood cell production; causes anemia. Damages chromosomes in bone cells; results in leukemia. Causes headaches, nausea, and poor concentration.
DDT	Colorless crystal or white powder. Water insoluble. Toxic.	Interferes with animal reproduction. Bioaccumulates. Highly toxic to fish.
EDB	Colorless liquid. Slightly water soluble.	Causes cancer and birth defects in animals. Toxic if ingested, inhaled, or if in contact with skin.
Endrin	White powder. Insoluble in water. Very toxic if inhaled or absorbed through skin.	Poisonous. Can produce convulsions, temporary deafness, mental confusion, nausea, and unconsciousness. Causes cancer and birth defects. Bioaccumulates. Kills not only target animals but those further up the food chain.
Ethylene glycol (active ingredient of antifreeze)	Liquid. Low corrosivity and ignitability. Toxic when ingested.	Affects kidneys and liver. Kills fish. Animals attracted to its sweet taste.
Hexavalent chromium	Purple crystals. Exists in solution as acid or salt. Reactive. Toxic.	Causes lung damage. Chronic exposure leads to liver and nerve damage. Toxic to aquatic organisms.
Hydrazine	Colorless liquid. Reactive. Ignitable.	Eye irritant. Toxic if ingested, inhaled, or in contact with skin.

Hazardous Material	Characteristic	Health or Environmental Effects
Mercury	Liquid metal. Water insoluble. Conducts electricity. Highly toxic if inhaled, ingested, or absorbed through skin.	Causes brain and nerve damage, mental retardation. (The term “mad as a hatter” comes from the bizarre behavior of hatters who used mercury in making felt and suffered brain damage as a result.) Causes birth defects and deformities.
Nitrobenzene	Greenish yellow crystals or oily yellow liquid. Slightly water soluble. Highly toxic if ingested, inhaled, or absorbed through skin.	High concentrations are poisonous. The effects of long-term, low-level exposure are not known. Effects can take several hours to show. Causes weakness, headaches, and interferes with production of red and white blood cells.
PCBs	Both colored and colorless liquids and solids. Toxic, prolonged exposure can cause death.	Causes liver and skin irritations (chloracne). Causes cancer.
Pentachlorophenol	Dark colored solid with a characteristic odor. Insoluble in water. Highly toxic if ingested or inhaled.	Skin irritant. Prolonged exposure causes dermatitis (skin irritations). Production process contaminates pentachlorophenol with dioxins.
Toluene	Colorless liquid. Insoluble in water. Ignitable. Reactive. Moderate toxicity.	Produces mild anemia. May produce liver or kidney damage or cause menstrual disorders.
1,1,1-Trichloroethane	Colorless liquid insoluble in water. Toxic and highly reactive with certain substances.	Suspected carcinogen. Effects of long-term, low-level exposure unknown. Can cause heart damage and affect mental functioning.

“What Waste Went Where”

Game Directions

1. Make sure that you have:
 - A map showing some of the hazardous waste sites in Washington State. The numbered locations are the ones that are part of this activity.
 - A number line.
 - Clue cards for your number line.
 - Worksheet for recording your answers. (Optional)
2. Place the map(s) and the number line face up in front of the group.
3. Shuffle the cards and then deal the cards face down so that each person in the group has about the same number of cards.
4. Sort your cards according to the categories WHAT, CONNECTION, WHERE, and FOLLOW-UP. There are less FOLLOW-UP cards than the others. Lay the sorted piles in front of you face up.
5. The person with the WHERE card “A” begins by reading this card out loud. With the help of the rest of the group, decide which numbered location is being described. Feel free to consult a Washington State road map or almanac, if necessary. Place the WHERE card face up under that number on the number line.
6. The person to the left of the person who started chooses a WHERE card from his own hand and, with other group members, tries to place it on the number line. If the location cannot be determined, return the card to the bottom of its pile. If the person to the left has no WHERE card, the next person to the left continues.
7. When all the WHERE cards have been placed under the number line, proceed to place the CONNECTION cards on their correct numbered locations. Keep in mind that each card is linked to a card in the other categories through key words or phrases. For example, one card might refer to ground water contamination and another card might mention drinking water pollution, or one card might describe the geography as a wet region and another card might refer to a city in a part of the state with a heavy rainfall. After the CONNECTION cards have been placed face up on the number line, continue with the WHAT and, if desired, the FOLLOW-UP cards.
8. Record your answers on the “What Waste Went Where” worksheet, especially if you are taking more than one day to complete this activity.

Answer Key to “What Waste Went Where”

LOCATION	WHERE	CONNECTION	WHAT	FOLLOW-UP
Number	Nearest City	Key Words That Connect Waste With Location	Hazardous Waste	How Or Why The Waste Got To This Location
1	Purdy (Port Orchard)	Transformers, PCBs, rain	PCBs	Utilities stored electrical transformers which contained PCBs
	G	D	J	
2	Kent	Yellow liquid, many different wastes	Nitrobenzene	Western Processing Plant stored and treated wastes for other companies
	M	H	A	B
3	Between Seattle and Tacoma (Midway)	Landfill, methane, leukemia	Benzene	Midway landfill is in a gravel pit. Methane gas migrated through porous soils
	K	K	B	A
4	Tacoma	Copper, ore, arsenic, Puget Sound	Arsenic and Cadmium	ASARCO Copper Smelter had metal-contaminated slag and released arsenic and cadmium from its smoke stacks before it was shut down
	L	F	E	D
5	Tacoma	Junkyard, drums, skin disease	Pentachlorophenol	Buffalo Don Murphy stored waste from a chemical company in his junkyard
	N	E	G	

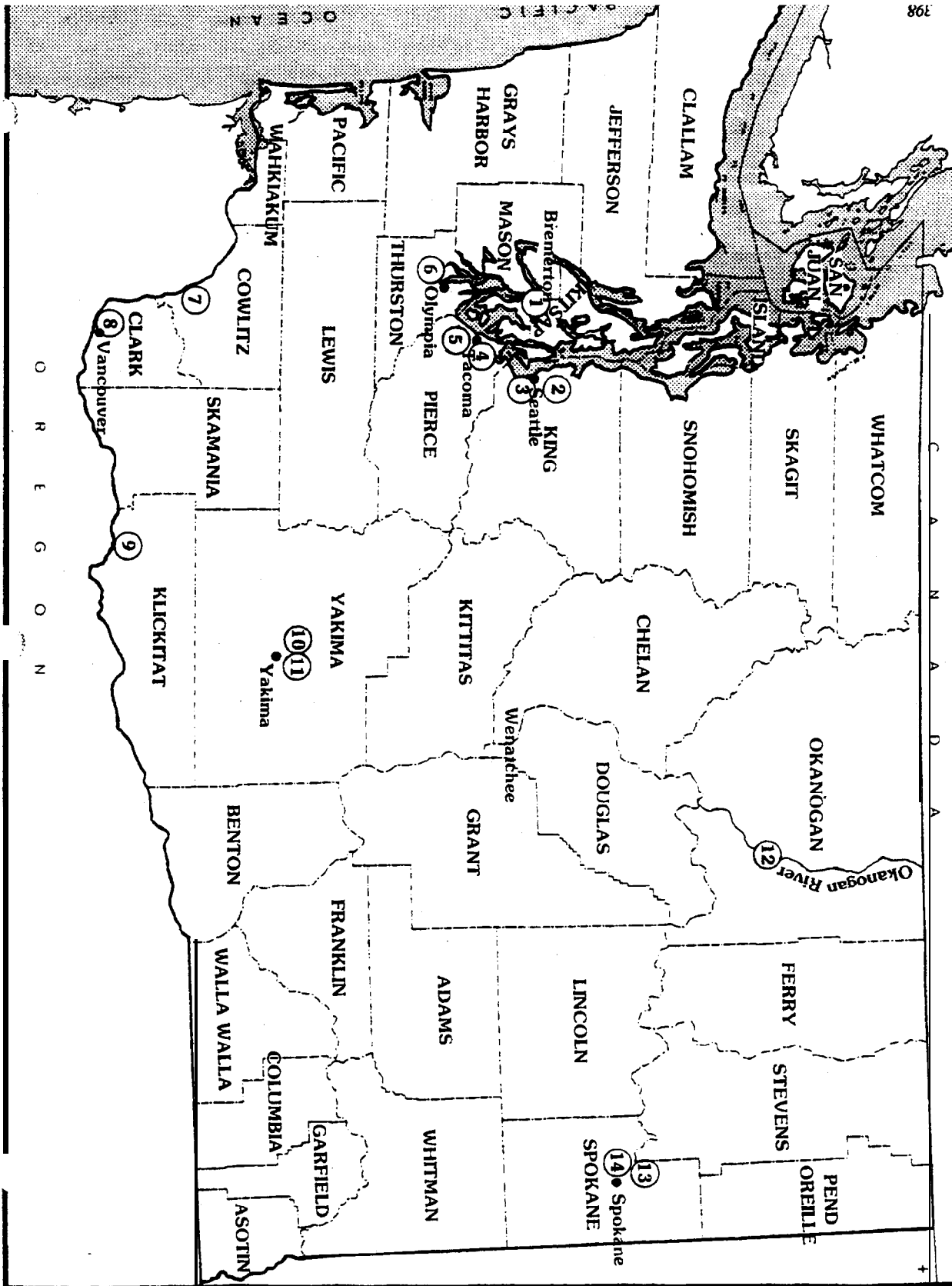
NOTE: Capital letters refer to the “What Waste Went Where” cards.

Answer Key to “What Waste Went Where”

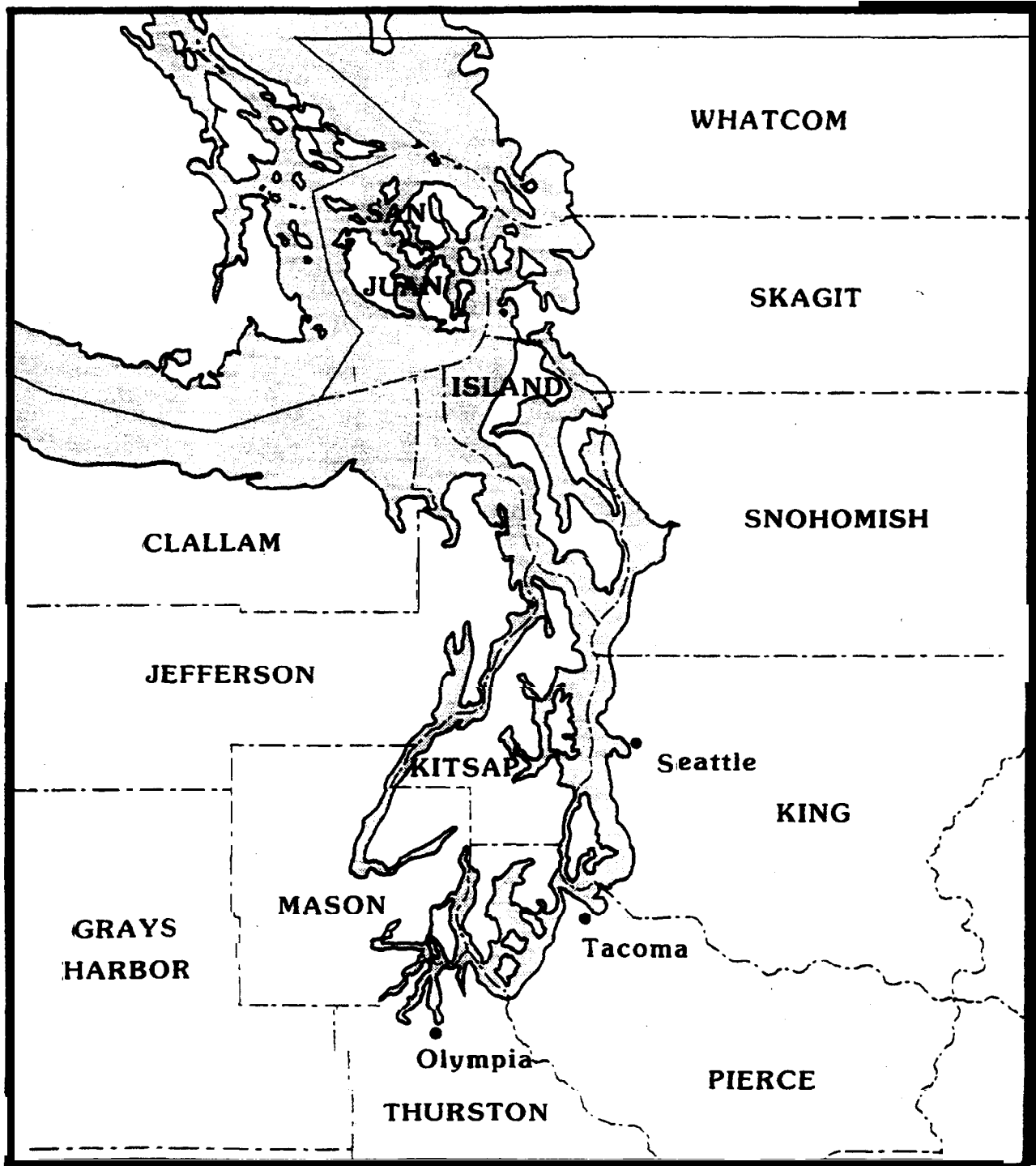
LOCATION	WHERE	CONNECTION	WHAT	FOLLOW-UP
Number	Nearest City	Key Words That Connect Waste With Location	Hazardous Waste	How Or Why The Waste Got To This Location
6	Olympia	Wells, ground water, mutations, strawberry farm	EDB	The pesticide EDB was applied in heavy doses and leached into ground water
7	A	A	D	Mercury waste from a chemical plant contaminated ground water
	Longview	Metal wastes, Columbia River	Mercury	
8	B	C	F	Waste from chromeplating was put in a dry well and entered the ground water
	Vancouver	Chromium, Vancouver, Columbia River	Hexavalent Chromium	
9	E	N	C	A train derailed and spilled antifreeze
	White Salmon	Hazardous Waste (antifreeze is not a serious hazardous waste)	Ethylene Glycol (antifreeze)	
	J	L	N	

Answer Key to “What Waste Went Where”

LOCATION	WHERE	CONNECTION	WHAT	FOLLOW-UP
Number	Nearest City	Key Words That Connect Waste With Location	Hazardous Waste	How Or Why The Waste Got To This Location
10	Yakima	Jet airplane fuel, ignitable	Hydrazine	An Air Force jet, forced to make an emergency landing, spilled fuel
	D	I	L	E
11	Yakima	Pesticides and food chain	DDT	Crop King Chemical Company manufactured pesticides, some of which reached ground water
	H	M	M	
12	Okanogan	Riverbank, pesticides dumped	Endrin (Pesticide)	A man cleaned pesticides out of his shed and dumped them on the bank of a river
	F	B	H	C
13	Spokane	Landfill, hazardous waste, nerve damage	1,1,1-Tri-chloroethane	Key Tronic Corporation dumped chemical degreaser into Colbert Landfill
	C	G	K	F
14	Spokane	Aquifer petroleum by-products	Toluene	Petroleum by products have been stored or spilled and are reaching ground water
	I	J	I	



PUGET SOUND Enlargement



Legend:

- County Borders
- Cities
- ~~~~~ Rivers

<p>DDT is a colorless crystal or white powder that is water insoluble and very toxic to fish. When DDT gets into a food chain, the top carnivores, such as bald eagles, may accumulate dangerous concentrations. Birds with high levels of DDT lay thin-shelled eggs that get smashed instead of hatching.</p> <p>What M</p>	<p>Ethylene glycol is slightly corrosive, moderately ignitable and toxic if ingested. Most antifreeze is made of ethylene glycol.</p> <p>What N</p>	<p>For Sale signs were everywhere. The City of Seattle has spent millions of dollars closing the nearby landfill and venting the methane. As a result of this enormously expensive remediation, Seattle now has among the highest garbage disposal rates in the country.</p> <p>Follow-up A</p>	<p>Western Processing was a chemical processing plant that operated from 1960 to 1983 in Kent. Environmental cleanup of this plant is costing millions of dollars.</p> <p>Follow-up B</p>
<p>An emergency cleanup of 24 identifiable pesticides took place along the bank of the Okanogan River. Six people worked 16 hours a day for three days to remove a total of 25 55-gallon drums of hazardous waste pesticides. The man who dumped the pesticides was located and indicated for endangering public health. A jury in Spokane cleared him of criminal charges because a majority of jurors thought that the man's actions did not make him a criminal.</p> <p>Follow-up C</p>	<p>A smelter in Tacoma has been closed. The dismantlement of this smelter is regarded as a Department of Ecology hazardous waste site and will cost millions of dollars to clean up. Heavy metal-contaminated smelter slag was used in building foundations all over Tacoma and is a serious health risk.</p> <p>Follow-up D</p>	<p>Airport personnel wanted to clean up fuel that spilled but a Department of Ecology official knew that the fuel was toxic and dangerous. If it touched anyone's skin or eyes. Experts from McChord Airforce Base, wearing protective suits and breathing apparatus, were called in and removed the fuel</p> <p>Follow-up E</p>	<p>The City of Spokane faces a \$62.8 million lawsuit because it gave approval for a company to dump chemical degreaser into one of the city's landfills.</p> <p>Follow-up F</p>

<p>Over 20 years, decomposing garbage produce large volumes of methane gas. This gas migrated over a quarter of a mile through porous, gravelly soils. Some entered basements of homes and businesses. Families had to leave their homes. Other hazardous liquids were produced from the garbage and have contaminated ground water. One of these is a liquid that can burn explosively and may cause leukemia.</p> <p>Connection K</p>	<p>Many train derailments have spilled hazardous materials ranging from sodium hydroxide to oil. One example is a train that derailed and spilled antifreeze along a riverbank.</p> <p>Connection L</p>	<p>A pesticide that was used extensively for killing insects is now banned in the United States. It was getting into food chains and interfering with the reproduction of large birds including bald eagles, ospreys, and brown pelicans. This pesticide used to be manufactured in Washington State and has been released into the environment in these locations.</p> <p>Connection M</p>	<p>Industrial waste was discharged into a dry well and has entered groundwater. The water soluble acidic hazardous waste may threaten the City of Vancouver's well field. If the waste gets into the ground water, it could cause serious health problems.</p> <p>Connection N</p>
<p>Nitrobenzene is an oily, yellow liquid that is highly toxic if drunk, inhaled or absorbed through the skin. Effects, which show up several hours after exposure, are weakness, headaches and reduced blood cell production.</p> <p>What A</p>	<p>Benzene is a colorless liquid that is ignitable and highly toxic. It interferes with red and white blood cell production and, at certain levels, can cause bone marrow damage and leukemia.</p> <p>What A</p>	<p>Hexavalent chromium is reactive, toxic and corrosive to skin. It is water soluble. Chronic exposure can lead to liver, nerve and lung damage. It is toxic to aquatic organisms. Hexavalent chromium forms chromic acid (H_2CrO_4) when it dissolves in water.</p> <p>What C</p>	<p>EDB (Ethylene Dibromide) is a colorless liquid pesticide, the use of which is now illegal. Used primarily on strawberry fields, EDB is toxic if inhaled, ingested or absorbed through the skin. At certain accumulations, it causes cancer and mutations (carcinogenic and teratogenic).</p> <p>What D</p>

<p>Arsenic is a brittle, grey, highly toxic solid. Its health effects, given intense or long-term exposure, may include cancer and birth defects.</p>	<p>Mercury is a liquid metal not soluble in water. It is highly toxic, causing, at certain concentrations, brain and nerve damage, mental retardation and birth defects. In the past, mercury was used in the making of felt. Hat makers, who produced the felt, were exposed to very high levels of mercury. Consequently, they often suffered mercury poisoning and brain damage and their resulting bizarre behavior lead to the expression 'Mad as a Hatter.' '</p>	<p>Pentachlorophenol is toxic and slightly water soluble. Pentachlorophenolis usually contaminated with small amounts of dioxin. Prolonged exposure can cause a skin inflammation called dermatitis.</p>	<p>Endrin is an acutely toxic white powder. One quarter ounce can kill an adult human. Exposure can produce convulsions, nausea, temporary deafness, mental confusion and unconsciousness. It has been used to kill mice that gnaw on the bark and roots of fruit trees during the winter.</p>
What E	What F	What G	What H
<p>Toluene is a colorless liquid that is ignitable and moderately toxic. If ingested, inhaled or absorbed through the skin, it produces mild anemia and may cause liver or kidney damage. Toluene is produced from petroleum.</p>	<p>PCBs occur in a range of colors and in liquid or solid forms. PCBs can cause cancer and kidney damage.</p>	<p>1,1,1-Trichloroethane is a colorless solvent that may cause nerve, liver or heart damage in humans. The health effects of long-term, low-level exposure is not known.</p>	<p>Hydrazine is a colorless liquid that is ignitable and very reactive. Hydrazine is toxic if breathed, eaten or absorbed through skin and it irritates eyes.</p>
What I	What J	What K	What L

<p>Liquid metal wastes from a plant operated by Weyerhaeuser, a wood products company, have contaminated soil and groundwater as well as sediments and fish in the Columbia River.</p>	<p>Old electrical transformers often contain PCBs. If the transformers are opened, PCBs can contaminate soil and water. When PCBs are burned,</p>	<p>The owner of a junkyard sold hazardous wastes as wood preservatives and insecticides. The chemical he sold as a preservative can cause a skin disease. This chemical and others leaked out of drums that he had stored in his junkyard. The chemicals have contaminated the soil.</p>	<p>Honeybees around southern Puget Sound were tested and found to contain high levels of the metals arsenic and cadmium. The bees pick up the metals as they forage. The honey they produced was not affected but survival of bees in some locations was not affected but survival of bees in some locations was reduced. Gardeners in these areas were advised not to eat their homegrown vegetables because of an increased risk of cancer or birth defects. The metals, found as impurities in copper ore, were carried for miles by hot gases from a smokestack.</p>
Connection C	Connection C	Connection E	Connection F
<p>Residents near a landfill must drink bottled water because their wells contain a hazardous waste that may cause nerve damage. The waste came from tons of chemical solvent that was dumped in the landfill between 1975 and 1980 by Key Tronic Corporation, a manufacturer of parts for computers.</p>	<p>A Spokane paint company was among 300 companies that sent their wastes to a chemical processing plant. The chemical processing plant handled a large variety of hazardous chemicals. Many of these hazardous wastes were unsafely handled and extensive environmental contamination has occurred.</p>	<p>A very reactive fuel used in a jet's backup generator system leaked onto the ground.</p>	<p>A nursery watered its trees with contaminated well water. The chain-link fence and concrete around the nursery turned an oily brown from the water and \$10,000 worth of uninsured trees were killed. The water contained petroleum by-products.</p>
Connection G	Connection H	Connection I	Connection J

<p>Hazardous petroleum by-products are leaching into the aquifer in an area a mile north of a city in Eastern Washington. The area on North Market Street has a long history of petroleum industries, tank farms, oil refineries and oil sales outlets dating back to 1938. Sixteen potentially responsible parties have been identified.</p> <p>Where I</p>	<p>A chemical that is not a serious hazardous waste was quickly removed from the environment before it could get into the Columbia River. The location was away from any large cities.</p> <p>Where J</p>	<p>Located between Seattle and Tacoma, a landfill was opened in the 1960s to receive demolition debris from road construction. The landfill, operated by the City of Seattle, was sited in a gravel pit surrounded by wetlands. The people living near the site were strongly opposed to the location, but were promised it would handle harmless wastes. However, all kinds of wastes were dumped there. Some wastes decomposed and released hazardous gases and liquids.</p> <p>Where K</p>	<p>The ASARCO Copper Smelter is located on peninsula in a large city on Puget Sound.</p> <p>Where L</p>
<p>A very toxic yellow liquid is just one of 90 different hazardous wastes that have contaminated the soil and are entering an aquifer. This aquifer was to be a future source of water for a city of about 28,000 people in densely populated King County.</p> <p>Imagine! How could so many different hazardous wastes end up in the same place?</p> <p>Where M</p>	<p>During the 1970s, Buffalo Don Murphy stored waste from Reichholz Chemical Company on his 5-acre rural property south of Tacoma. The property is located on a filled wetland near a creek used for irrigation and watering livestock. Over 1000 drums of different wastes generated from the manufacture of industrial disinfectants were stored at Buffalo Don's junkyard.</p> <p>Where N</p>	<p>For 3 years, the pesticide terroicide, which is 54% EDB, was applied to a 12-acre Western Washington strawberry farm at a rate of 18-20 gallons per acre. EDB polluted nearby groundwater.</p> <p>Connection A</p>	<p>Among discarded pesticides were 14 gallons of parathion, 13 pounds of lindane and 2 gallons of endrin. Because of the risks they pose to public health and environment, all of these pesticides are illegal to use in Washington State.</p> <p>Connection B</p>

<p>Residents of 22 homes have to drink bottled water until a new source of drinking water is provided. Although their well water looks and smells fine, a hazardous waste that it contains could cause cancer or mutations.</p> <p>The hazardous substance reached the water table underneath a farm near Olympia.</p>	<p>From 1956 to 1975 a Chloralkali Plant in Longview produced chlorine gas and caustic soda for an adjacent pulp mill. Metal wastes from the process present serious potential health problems.</p>	<p>The levels of a hazardous waste in some wells near the Colbert Landfill, 8 miles north of Spokane, exceeds 9600 parts per billion. A level of 200 parts per billion is considered safe. A Spokane company dumped a hazardous waste in the Colbert Landfill. The plume of contamination is spreading south and west in the aquifer under the landfill.</p>	<p>A jet fighter was forced to make an emergency landing at Yakima Airport on the city's westside.</p>
Where A	Where B	Where C	Where D
<p>A chromeplating company named Frontier Hard Chrome operated from 1970 to 1983 half a mile north of the Columbia River. Industrial waste from the company was discharged in a dry well and has entered groundwater.</p>	<p>An individual, who was moving, dumped his stored pesticides on the bank of a river in central Washington.</p>	<p>Seattle City Light and other utilities stored their old electrical transformers in a junkyard in Purdy south of Bremerton. When it rained, the hazardous waste from the transformers was carried to a saltwater lagoon. Small animals in the lagoon have the hazardous waste in their systems.</p>	<p>Crop King Chemical Company manufactured pesticides in a major orchard fruit-producing area in central Washington. Many of the leftover pesticides at the company's location have contaminated the soil and maybe the groundwater.</p>
Where E	Where F	Where G	Where H

NUMBER LINE FOR ACTIVITY "WHAT WASTE WENT WHERE"

First, cut along dashed lines. Then apply glue to gray-shaded areas to make one continuous strip (1-14).

276

1

2

3

4

5

6

7

8

9

10

11

12

13

14

A-Way With Waste

What Waste Went Where Worksheet?

Location Number	WHERE Nearest City	CONNECTION Key Words That Connect Waste with Location	WHAT Hazardous Waste	FOLLOW-UP How Or Why The Waste Got To This Location
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Evaluation Of Group Participation In Cooperative Learning Activity

Circle one number for each statement.

1 = poor

5 = super

1. Everyone in the group participated.

1 2 3 4 5

2. People in the group explained things to other people in the group.

1 2 3 4 5

3. People in the group did not “put down” other people in the group.

1 2 3 4 5

4. People in the group listened to each other.

1 2 3 4 5

Total group participation score = _____

Investigating Environmental Professions

Subjects: Career Education, Chemistry, Biology, Earth Sciences

Grades: 9-12

Teaching Time: 30 Minutes Initially, Followed By Research and Reporting

Focus: Environmental Protection, Waste management, Environmental Careers

Rationale

Career opportunities in environmental management and protection, particularly in solid and hazardous waste management, are expanding.

Learning Objective

Students will:

- Discover career opportunities in environmental management and protection.
- Identify trade magazines and professional publications as sources of information about careers.
- Develop skills in using libraries.

Teacher Background

As our awareness and knowledge about environmental degradation resulting from past toxic waste disposal practices have increased, both federal and state legislatures have passed so-called Superfund bills mandating the cleanup of hazardous dumpsites. Cleanup costs for the more than 600,000 toxic sites scattered across our country have been estimated at more than \$300 billion over the next 50 years.¹

Washington State emphasizes the waste management processes of reduction and

prevention. Thus, solid and hazardous waste management today is much needed service, offering a range of employment opportunities. Students can learn about these opportunities by researching trade and professional publications dealing with waste management and environmental protection.

Materials

Two handouts:

- List of professions concerned with solid and hazardous wastes and environmental management and protection
- List of trade journals and professional publications

Pre & Post Test Questions

1. Can you name three jobs/careers in environmental management and protection?
2. Can you name three publications offering information about careers in environmental management and protection?
3. Can you list three school classes that environmental protection professionals need?

Learning Procedure

1 Write the number \$300,000,000,000 on the board. Tell students this is the estimated cost of cleaning up hazardous dumpsites over the next 50 years. **Say:** "Jobs related to cleanup activities are expected to increase sevenfold in the next ten years." Discuss the Washington State waste management priorities of reduction, recycling, treatment, incineration, and landfills. **Say:** "Disposal of solid and hazardous waste is now the least preferred waste management." (For more background on the management priorities, see the activity "Hazardous

¹ Michael Stanton, "Hazardous Wastes: Who's Cleaning Up?" Occupational Outlook Quarterly, Winter 1987, Vol. 31, No. 4, p. 3.

Waste in My Home Town?" p. 247.) Tell students that as industries work to implement these priorities many new jobs are expected to open up.

2 Have the class brainstorm a list of environmental management and protection occupations: for example, toxicologist, hydrologist, environmental attorney, natural resource manager for a government agency, environmental chemist, and spill engineer.

3 Distribute the handout listing the environmental management and protection occupations. Combine this list with the one just generated by the class.
Have each student choose an occupation of interest.

4 Provide students with the publications listed on other handouts or give students the assignment of finding as many of these publications as possible in the nearest large library. (Teacher: You may want to alert your School Librarian prior to doing this activity.) If your school or local library does not have or cannot obtain any of these publications, other sources are:

- State Departments (Ecology, Natural Resources, Fish and Wildlife, etc.)
- Municipal (City or County) Engineering Department
- Private or public waste haulers or recyclers
- Private waste management companies.

Look in the yellow pages of your local telephone book.

5 Have students research a specific environmental career using the listed publications and other appropriate sources, such as the classified ads in the Sunday newspapers of any large city.

Have students prepare a report on their research that includes information on the following:

1. What do people in this profession do? Why is their work important?
2. How do people begin careers in this field?
3. What are the educational requirements for entering this field?
4. In what kinds of companies and organizations are professionals in this field employed?
5. How much money do professionals in these occupations make?
6. How do these occupations work to protect the environment?
7. What is the future outlook for this occupation?

Extended Learning

1 Have students identify companies and organizations in your area where environmental professionals are employed. Research the descriptions of the environmental jobs these companies offer.

2 Invite an environmental professional to speak to your class. Call the Department of Ecology Regional Office in your area to arrange for a speaker.

3 Follow a waste from its creation to its ultimate disposal and describe the jobs associated with this process. For example, chemists create a hazardous substance, chemical engineers and technicians design the processes which generate it. A toxicologist will test it to determine its potential for long-term harm to humans and animals. Transporting it will entail certain jobs. A sanitary engineer or a biochemist might be concerned with its disposal.

Bibliography

Stanton, Michael. "Hazardous Wastes: Who's Cleaning Up?" Occupational Outlook Quarterly. Winter 1987, Vol. 31, No. 4, pp. 3-14.

"Two States to Hire 500+ Hazardous Waste Officials." Waste Age. June 1988, p. 28.

Watson, Tom. "The Job Explosion." Resource Recycling. May-June 1988, p. 24.

"Which Niche?" Project Wild. Boulder, CO: Western Regional Environmental Education Council, 1985.

Environmental Management, Protection, and Information Publications

Chemical Week

Waste Age

Waste Management

Resources Recycling

EPA Journal

Scientific American

Science

Nature

Environmental Progress

Amicus Journal

Chemical and Engineering News

Earthcare Northwest

Resources and Conservation

National Wildlife

Environmental Management

Northwest Energy News

Hazardous Wastes

(List others you found here.)

Public Affairs

Environmental Management and Protection Professions

- Attorney** - environmental issues specialization
- Biologist** - hazardous waste inspection
- Chemical Engineer** - toxic waste management
- Chemist** - hazardous waste inspection
- Civil Engineer** - hazardous waste inspection
- City/County Planner** - waste reduction and recycling management
- City/County Recycling Education Coordinator** - recycling education
- Consultant** - solid and hazardous waste management
- Environmental Educator** - waste management and recycling
- Environmental Engineer** - solid waste management
- Environmentalist** - spill response
- Environmental Planner** - waste reduction, recycling, environmental assessment, shorelines management
- Environmental Technician** - permit data processing, field investigation
- Fisheries Manager** - spill response
- Hydrologist** - solid waste reduction
- Legal Assistant** - solid waste management practices
- Recycler** - private business and industry
- Research Assistant** - recycling programs, waste management
- Resource Geographer** - hazardous waste inspection
- Sanitary Engineer** - solid waste management
- Technical Writer** - environmental impact assessment
- Wastewater Treatment Plant Operator/Technician** - solid waste management

How Very Little It Must Be

Subjects: Math, Chemistry

Grade: 11-12

Teaching Time: One Class Period

Focus: Drinking Water and Ground Water Contamination, Chemical Concentrations, Drinking Water Standards, Parts Per Million (ppm), Parts Per Billion (ppb)

Rationale

While the measurements parts per million (ppm) and parts per billion (ppb) are widely used in studying environmental contamination, the relative size of these measurements can be difficult to visualize.

Learning Objective

Students will:

- Working from data, gain experience calculating ppm and ppb.
- Understand how proportionally small a ppm and a ppb are.
- Understand that a very little of some contaminants goes a very long way.

Materials

Student Handout:

- How Very Little It Must Be - Problem Worksheet

Pre & Post Test Questions

1. What is a part per million? How is it abbreviated?
2. Name two units that describe volume.

Learning Procedure

1 Some environmental contaminants are so hazardous that we need to measure them in terms of ppm or even ppb. What do these terms mean?

(A ppm is a proportion in which one unit of a substance is found in a million units of surrounding material such as air, soil, or water. One ppm is proportional to one second in twelve and a half days (300 hours). A ppb is a proportion in which one unit per billion is measured. One part per billion is proportional to one second in 32 years.)

2 Provide students with the following information:

- Clear Lake is a 100-acre lake, with an average depth of 25 feet.
- Swimming Pond covers one acre, with an average depth of 10 feet.
- Deep Rock Aquifer extends over 50 square miles, with an average depth of six feet.

Drinking Water Standards

Listed on the next page are some of the chemicals or compounds that can contaminate our drinking water, along with the federal standards for the maximum acceptable levels allowed in both ppm and ppb.¹

Benzene - 0.005 ppm = 5 ppb

Arsenic - 0.05 ppm = 50 ppb

2,4-D - 0.07 ppm = 70 ppb

1,1,1-Trichloroethane (TCE) - 0.2 ppm = 200 ppb

Fluoride - 4 ppm = 4000 ppb

¹ Code of Federal Regulations, Title 40, Part 141.

Conversion Table

1 cubic foot	=	7.48 gallons
1 gallon	=	.1337 cubic feet
1 acre	=	43,560 square feet
1 square mile	=	27,878,400 square feet

3 Using the information above, have students solve the following problems (Answers are given in parenthesis):

- The EPA Criminal Investigations unit is attempting to track down the parties responsible for dumping five gallons of the herbicide 2,4-D in Swimming Pond. If the chemical becomes evenly dispersed, what would be its concentration in ppm? (1.534) In ppb? (1,534) Should the EPA restrict access to Swimming Pond? Why?
- The State Highway Patrol has notified the Department of Ecology that six gallons of benzene were accidentally spilled into Clear Lake. If it is evenly dispersed, what would its concentration be in ppm? (0.00738). In ppb? (7.38) **Ask:** "Should the residents who depend on the lake for drinking water be notified? Why?"
- An old rusted, unmarked 55-gallon drum was discovered on the property of a resort near Clear Lake. Although the manager suspects it may contain a hazardous chemical, he asks his assistant to get rid of it any way he can. Calculate the concentration of contaminant in ground water if a 55-gallon drum of the chemical were illegally disposed of in an old well and dispersed evenly throughout Deep Rock Aquifer. (0.000879 ppm or 0.879 ppb) What if the same quantity of the chemical

were illegally disposed of in Clear Lake? (.0675 ppm or 67.5 ppb). In Swimming Pond? (16.9 ppm or 16,900 ppb)

- Suppose a 5,000-gallon tank truck loaded with the chemical arsenic ran off the highway and all the chemical spilled into Clear Lake. What would be the concentration of chemical in the lake? (6.138 ppm or 6,138 ppb) Does this violate federal standards?

4 Have students compare their calculations to the federal drinking water standards for all the chemicals listed above.

Ask: "Which 'incident' was the worst in terms of contamination?" "Which scenario(s) didn't violate any of the standards?" "How many of the cases violated the benzene standards? The TCE standard?"

5 Discuss possible ways of dealing with each of these problems. (Calling the Department of Ecology's Emergency Spill Response Section; determining civil or criminal penalties for violators; educating the public as to potential threats to human health and to fish and wildlife; restricting access to contaminated waters; developing plans to prevent similar contaminations in the future, etc.)

Extended Learning

1 To illustrate the large volumes of water that can be contaminated by a small amount of pollutant, do the red dye demonstration in "A Little Can Go A Long Way," p. 225.

2 Have students research the chemicals used above as to their industrial or household uses and potential health hazards.

3 If you have access to a computer, have students use a spreadsheet or write a short computer program that would calculate the answers to the problems above.

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National Archives and Records Administration. Code of Federal Regulations, Washington, D.C.: Office of the Federal Register, 1995, Part 141.

Ontario Waste Management Corporation. Hazardous Waste Education Resource Kit. Toronto, 1985.

Ontario Waste Management Corporation. "Units of Measure Chart." Hazardous Waste in Ontario. Toronto, 1986, p. 19.

“How Very Little It Must Be” Problem Worksheet

Student Handout

1. The EPA Criminal Investigations unit is attempting to track down the parties responsible for dumping five gallons of the herbicide 2, 4-D in Swimming Pond. If the chemical becomes evenly dispersed, what would be its concentration in ppm? In ppb? Should the EPA restrict access to Swimming Pond? Why?
2. The State Highway Patrol has notified the Department of Ecology that six gallons of benzene were accidentally spilled into Clear Lake. If it is evenly dispersed, what would its concentration be in ppm? In ppb? Should the residents who depend on the lake for drinking water be notified? Why?
3. An old rusted, unmarked 55-gallon drum was discovered on the property of a resort near Clear Lake. Although the manager suspects it may contain a hazardous chemical, he asks his assistant to get rid of it any way he can. Calculate the concentration of contaminant in the ground water if a 55-gallon drum of the chemical were illegally disposed of in an old well and dispersed evenly throughout Deep Rock Aquifer.

What if the same quantity of the chemical were illegally disposed of in Clear Lake? In Swimming Pond?

4. Suppose a 5,000-gallon truck loaded with the chemical arsenic ran off the highway and all the chemical spilled into Clear Lake. What would be the concentration of chemical in the lake? Does this violate federal standards?

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Listed below are some of the chemicals or compounds that can contaminate our drinking water, along with the federal standards for the maximum acceptable levels allowed in both ppm and ppb.

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Fluoride - 4 ppm = 4000 ppb

Conversion Table

1 cubic foot	=	7.48 gallons
1 gallon	=	.1337 cubic feet
1 acre	=	43,560 square feet
1 square mile	=	27,878,400 square feet

Water Body Dimensions

Clear Lake - 100-acre lake, 25 feet deep

Swimming Pond - 1 acre, 10 feet deep

Deep Rock Aquifer - 50 square miles, 6 feet deep

What's Hazardous At Home?

or Meet Mr. Yuk

Subjects: Science, Social Studies, Health

Grades: 2-6

Teaching Time: One Class Period

Focus: Household Hazardous Substance Storage and Disposal, Health and Safety, Map Skills

Rationale

Some household products may be harmful if handled improperly.

Learning Objective

Students will:

- Learn about some common household products that may be hazardous if not used and disposed of carefully.
- Identify places in their homes where these potentially hazardous materials may be found.
- Learn about Mr. Yuk and how he can prevent them or their younger brothers and sisters from swallowing something harmful.

Teacher Background

People have become concerned about the health effects of hazardous materials stored, used, or disposed of in their houses and communities. Consumers generally have little information about the long-term effects of chemicals contained in common home and garden products. Many products and chemicals that were once considered "harmless" have now been linked to health problems, due to exposures over long periods. These health effects can be as mild as fatigue and headaches or as serious as cancer. Often products combine with other substances in the environment, creating a reaction which is more hazardous than the individual chemical effects.

A substance that is classified as hazardous is required to bear labeling with warning statements and safety information if it is packaged for, or intended for, use in or around the home. The U.S. Consumer Product Safety Commission has established specific labeling requirements; however, labels required for various hazardous substances differ. This, in addition to the considerable amount of label information required, can make it very difficult to determine how to use, store, and dispose of a product safely.

Materials

- Packages and labels from potentially hazardous household products. (See accompanying list entitled "What's In Your House?") Make sure any packages are well sealed, not leaking, and are stored in a secure cupboard when not in use.
- Mr. Yuk stickers (See Resources)

Pre & Post Test Questions

1. What are the four categories of hazardous substances?
2. What can you do if you have pesticides in your home that you want to dispose of?
3. Where should you look first to find out if a household product is potentially harmful?
4. When you see Mr. Yuk's face on a bottle or can, what does this mean?
5. What should you do if you find someone eating or drinking something harmful or poisonous?
6. (Grades 5-6) What is an antidote?

Learning Procedure

- 1 Explain to students that there are products we use at home that may be hazardous if not handled and disposed of carefully. Explain that

hazardous means dangerous and that hazardous substances are likely to cause harm to the environment or to humans because they are either toxic (poisonous), flammable (quickly burnable), reactive (explosive), or corrosive (substances that rapidly eat into or dissolve away what they touch).

Ask: “Where at home might we look to find some of these products that require careful handling?” Let’s draw a map — called a floor plan — of our houses and find out.

2 Have each students draw a floor plan of his or her house and garage.

3 Project and hand out copies of the following overhead entitled “What’s In Your House?” (NOTE: This overhead and other hazardous waste activities for schools are from SLEUTH: Educational Activities on the Disposal of Household Hazardous Waste, available from Metro, Water Quality Division, Municipality of Metropolitan Seattle.) Go over the list with students, identifying and describing the less familiar products such as antifreeze, paint strippers, varnishes, and drain cleaners. Students may be more familiar with brand names of particular products.

4 Using the previously drawn floor plans, have students mark where in their houses the listed products might be found.

5 Show students packages and labels from a number of products on the list.

Ask: “Where on a label or package can you look to find out if the product might be harmful?” “What will the package or label say?” (Package or label may say “Danger/Poison,” “Warning,” “Caution,” or “Keep out of the reach of children,” and then will list the possible harmful effects of the product.)

Ask: “How and where should products such as these be stored?” Draw an arrow on your floor plan showing where hazardous waste materials should be moved to a new location for safety.

Ask: “How can you get rid of potentially harmful products you no longer need without damaging the environment or other people?” (For answers, refer

to the accompanying “Product Disposal Recommendations,” pp. 290-291.)

Ask: “How many of you know about Mr. Yuk?” “When you see Mr. Yuk’s scowling face, what does that mean?” (Mr. Yuk is the warning symbol of Children’s Orthopedic Hospital’s Poison Control Center. Children should know that anything with a Mr. Yuk symbol on it is poisonous.) Draw a big Mr. Yuk symbol on the board or show Mr. Yuk stickers.



Ask: “How many of you have younger brothers and sisters?” “How could Mr. Yuk help if you found your little brother or sister eating or drinking something from the list we’ve been talking about?” (By calling the Poison Control Center listed in your phone book, you can find out exactly what is in any of the products so you can tell the doctor. The doctor can then prescribe the correct antidote.)

Ask: “How and where should the products on the list be stored so small children can’t get them?”

6 Have students take home the marked floor plans, the list of potentially harmful household products, and the information about Mr. Yuk to share with their families. Ask students to put a Mr. Yuk sticker on the phone at home.

Product Disposal Recommendations

1. General Precautions:

- Keep all chemical wastes out of the reach of children.

- Read the label before handling any household chemicals.
- Household wastes should not be mixed together.

2. Pesticides and Wood Preservatives: Pesticides should not be disposed of in the trash can or down the drain. Call your local health department district office for recommendations, or the Washington State Department of Ecology Recycling Hotline 1-800-RECYCLE.

3. Automobile Oil: Recycle at local gas station or call the Department of Ecology Recycling Hotline, 1-800-RECYCLE, for the location of the nearest oil recycler.

4. Antifreeze: Do not pour antifreeze into storm drains or sewers, as these may be directly connected to streams.

5. Paint Solvents: When possible, reuse paint solvents by letting the paint sludge settle and reusing the solvent. If solvent is not reusable, call the Department of Ecology Recycling Hotline, 1-800-RECYCLE.

6. Paint: Some charities accept excess paint. Small amounts of latex (water base) paint can be left open to dry in a safe place. The paint can and its dry contents can be disposed of in the trash.

7. Contact Department of Ecology Recycling Hotline, 1-800-RECYCLE, for information regarding all the above products.

Extended Learning

- 1 Do the activity "Hazardous Waste Hot Potato" on pp. 293.

Acknowledgment

Special thanks to Julie Sellick and John Conroy, Washington State Department of Ecology, for help with this activity.

Resources -

Mr. Yuk stickers are available at your local Poison Control Center. Your local Poison Control Center is listed inside the front cover of your telephone directory.

Washington Poison Center, 155 NE 100th, Suite 400, Seattle WA 98125

King County Solid Waste Division curriculum, "Hazards on the Homefront," 4th-12th grades, January 1995.

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Toteff, Sally and Cheri Zehner. Toward Hazardless Waste. Seattle: Seattle-King County Department of Public Health, 1985.

*For more updated bibliography, see "Hazards on the Homefront" under Resource curriculum listed above.

What's In Your House?

Potentially dangerous household wastes might be found in many places in the home.

All of us who use these products know how beneficial they are,
but might they also harm us? or others?

PET FLEA COLLARS

FLOOR POLISH

TOILET BOWL CLEANERS

ROACH SPRAY

SLUG BAIT

PAINT THINNER

LAUNDRY SOAP

MILDEW PROOFING

WEED KILLERS

LACQUER THINNER

OIL

WOOD PRESERVATIVES

ANTIFREEZE

RAT POISON

BRAKE FLUID

NO-PEST STRIPS

OIL BASED PAINT

BATTERIES

DRAIN OPENERS

STAINS/VARNISHES

ENAMEL PAINTS

FURNITURE POLISH

PAINT STRIPPERS

MOTHBALLS

ROOM DEODORIZERS

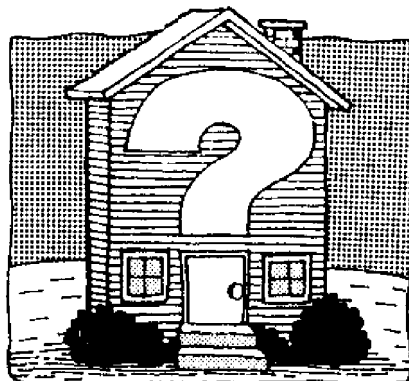
DISINFECTANT CLEANERS

OVEN CLEANERS

POWDERED BLEACHES

GLASS AND WINDOW CLEANERS

SCOURING POWDER



Hazardous Waste Hot Potato

Subjects: Science, Social Studies

Grades: 4-6

Teaching Time: One Class Period

Focus: Household Hazardous Wastes, Warning Words and Terms, Hazardous Characteristics

Rationale

Many useful products are hazardous. The typical household stores about 60 products with hazardous properties. These products, when handled or disposed of improperly, can endanger human health and harm our environment. We should consider how each of us generates hazardous waste and our responsibility for its safe management and disposal.

Learning Objective

Students will:

- Learn what characteristics make a substance hazardous.
- Learn the signal words for hazardous substances.
- Learn the definitions for terms related to household hazardous waste.
- Recognize their responsibility for safe disposal of household hazardous waste.

Teacher Background

Many common household products contain hazardous substances. Washington citizens dumped 11.8 million pounds of household hazardous wastes in landfills in 1994.¹ When these wastes are discarded in landfills, the unused portions can accumulate and, over time,

contaminate water supplies or emit harmful vapors. Because of tightening hazardous waste disposal regulations, the closure of landfills, and the realization that these wastes present health and environmental problems, our public officials are faced with the problem of what to do with wastes from a variety of sources that in the past were assumed to be harmless. This activity introduces the many problems associated with hazardous wastes and looks at how we might manage hazardous wastes for the benefit of people and the environment.

Study the three overheads before teaching this lesson to familiarize yourself with the terms used to describe hazardous substance characteristics and toxicity ratings.

The four disposal options and products in the game are:

Recycle: (motor oil, auto battery, transmission fluid, etc.)

Trash for the landfill: (empty aerosol can, empty cleanser, etc.)

Hazardous waste collection: (rat poison, 1/2 full drain opener, etc.)

Flush down drain: (ammonia household cleaner, dish detergent, etc.)

You should be able to explain why a sewer line can take certain items that a septic tank can't. (The bacteria in the septic tank may be killed by these toxic household items or they may be released to the ground water by failing septic systems; whereas the sewage treatment plant chemically breaks down the toxics.) This is one reason not to dump things in the sink. Ask the class for others. Be prepared to explain to the class what a sanitary landfill is. Household hazardous waste collection programs

¹ Washington State Department of Ecology, Solid Waste in Washington State, Fourth Annual Status Report, Including the 1994 Recycling Survey, February 1996, publ. # 96-500.

safely store, reuse, treat, or dispose of a community's household hazardous wastes.

Materials

Teacher:

- Four examples of hazardous household products as overheads or handouts. Choose one from each of those listed with disposal options shown above.

For Each Team:

- ten "hot potatoes" (these may be potatoes, eggs, wood blocks, or plastic containers, etc.)
- ten household product sticker labels for the ten household products
- ten toxic warning stickers
- five corrosive warning stickers
- five flammable warning stickers
- two irritant warning stickers (sample warning stickers), on p. 295

Four depositories marked with different disposal option for each team: boxes, bags, wastebaskets, or designated areas.

Overheads: "Hazardous Substance Warnings," "Hazardous Substance Toxicity Chart," and "Hazardous Substance Characteristics."

Pre & Post Test Questions

1. (Grades 3-4) What are six household "why hazardous" words? (Grades 5-6 - define the words).
2. What is toxicity? What are the three warning words for the degrees of toxicity?
3. What are four common disposal methods for household hazardous wastes?

Learning Procedure

- 1 Explain the dangers of household hazardous substances to the class. Tell them, for example, that 125 people a day in the U.S. are poisoned by pesticides.²
- 2 Show each of the four household hazardous product examples to the class. (Be certain that your containers are empty and safe for display in the classroom.)
- 3 Read aloud to the class any warnings on the labels.
- 4 Show the overhead "Hazardous Substance Toxicity Chart." Explain the three degrees of toxicity. Ask the class if they have items in their homes that meet the different degrees of toxicity.
- 5 Show the overhead "Hazardous Substance Characteristics." Carefully go over the definitions.
- 6 Ask the students to make a list of five hazardous items in their own homes. Ask how the items are stored. Discuss which hazardous signal words you would find on these items. Discuss what you would do with these items when you are finished with them. (Examples might be to throw in trash, dump on ground—almost never, flush down drain—rarely, store in basement or garage, share usable products with neighbors.)
- 7 Show the overhead "Hazardous Substance Warnings." Outline to the class each of the four disposal methods on the overhead (recycle, hazardous waste collection, trash for landfill, and flushing down a toilet). Explain here the difference between a septic tank and a sewer line system to a treatment plant.
- 8 Now, cover the overhead. Ask the class which of the four disposal methods they think is appropriate for each of the display items.

2 Tom Parker, In One Day, Detroit: Gale Research Col, 1984, p. 45.

9 Tell the class that they will be given an opportunity to work as teams to decide the proper disposal of ten household hazardous waste items. Then explain the rules of the game from the attached sheet. They may consult one another for advice, and each team may be given a copy of the "Hazardous Substance Warnings" overhead. Play the "Household Hazardous Waste Disposal Game."

Extended Learning

- 1** Have the class make an inventory of the household hazards in their home, and bring the list to class.
- 2** Call the Department of Ecology Recycling Hotline, 1-800-RECYCLE, and find out when they have hazardous waste collection days in your area.
- 3** If your city or county has a permanent hazardous waste collection site, arrange a visit.

Resources -

King County Solid Waste Division curriculum, "Hazards on the Homefront," 4th-12th grade, January 1995.

Bibliography

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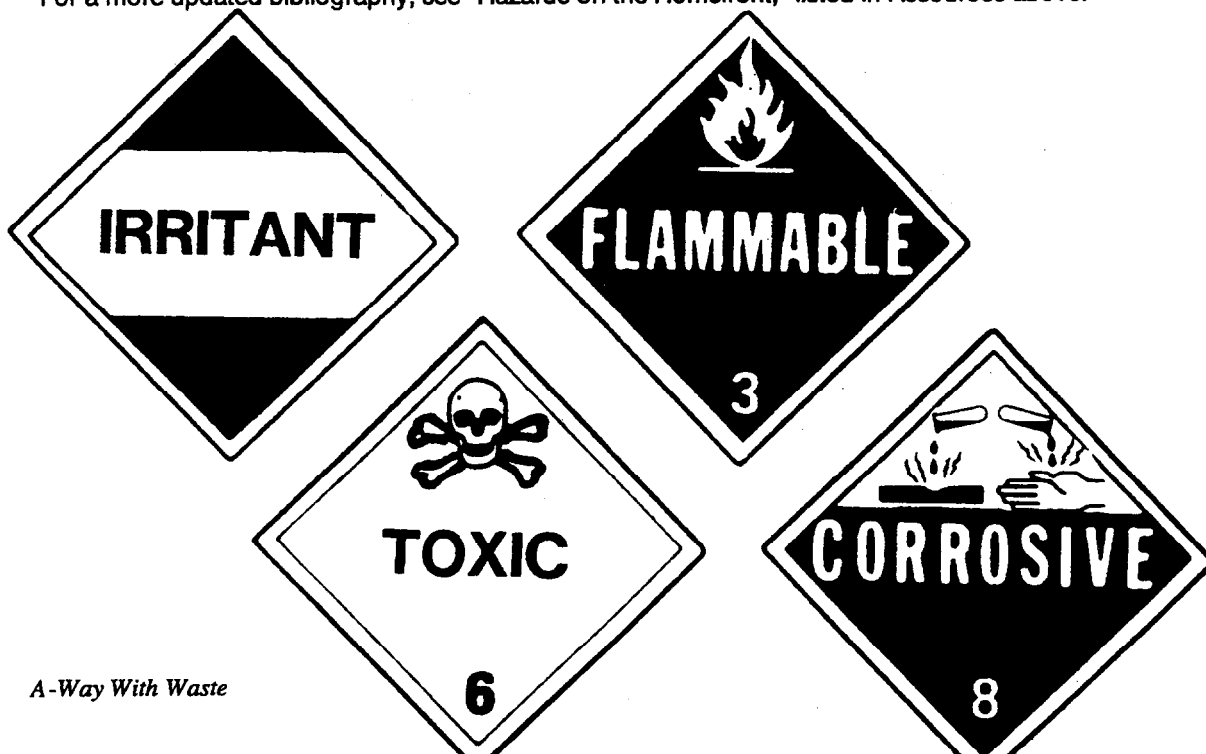
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Pringle, Lawrence. Throwing Things Away: From Middens to Resource Recovery. New York, N.Y.: Thomas Y. Crowell Junior Books, 1986.

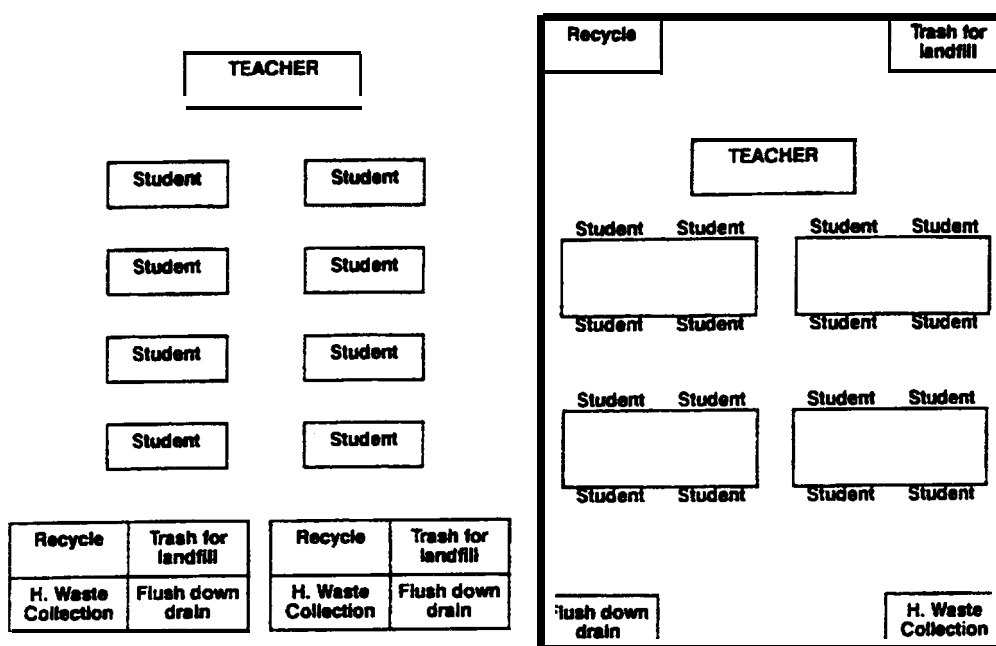
Schwartz, Anne. "Poisons in Your Home: A Disposal Dilemma." Audubon, May 1987, Vol. 89, No. 3, pp. 12-16.

For a more updated bibliography, see "Hazards on the Homefront," listed in Resources above.



Household Hazardous Waste Disposal Game

Class arrangement options for game



Rules

1. Each team has ten hot potatoes, ten household product name stickers, and a pile of warning word stickers to attach to the potatoes.
2. The team has a twenty-five second time limit to place the product name on the potato, apply the proper warning stickers, and place the potato in the proper depository.
3. A designated team member applies the household product name sticker and the appropriate warning label(s).
4. If the potato is not in the depository at the end of the time limit, the person holding the potato must keep it at his or her desk. (This represents littering.)

Keeping Score

1. One point for each proper warning sticker for each product.
 2. Two points for placing the potato in the proper depository.
 3. Two points are deducted for placing the potato in the wrong depository.
 4. Two points are deducted for littering.
 5. One point is deducted for applying an incorrect label.
 6. The team with the most points after the disposal of all ten potatoes wins.
- Depositories can be boxes, bags, baskets, or designated areas of the classroom.

Hazardous Substance Warnings

Item	Why Hazardous	Disposal
Auto battery	Corrosive, toxic	Recycle
Drain cleaner	Corrosive, toxic	Give to someone to use up or Hazardous Waste Collection
Empty aerosol can	Flammable, toxic	Place in trash for landfill
Household cleaners with ammonia	Corrosive, toxic, irritant	Give to someone to use up or flush down drain
Oil based paint	Flammable, toxic	Give to someone to use up or Hazardous Waste Collection
Oven cleaner	Corrosive, toxic	Give to someone to use up or Hazardous Waste Collection
Rat poison	Toxic	Hazardous Waste Collection
Roach and ant killer	Toxic	Hazardous Waste Collection
Transmission fluid	Flammable, toxic	Recycle
Used motor oil	Flammable, toxic	Recycle

Household hazardous waste disposal method recommendations are subject to change as new information is obtained about chemical products. For current disposal recommendations, contact Washington State Department of Ecology's Recycling Hotline toll-free at 1-800-RECYCLE.

Hazardous Substance Toxicity Chart

Warning Word	Toxicity*	Examples
CAUTION OR WARNING	Moderately to very Toxic Lethal dose: A teaspoon to a pint	Ammonia Most paints Floor polishes Antifreeze Bleach Some fertilizers Many pesticides
DANGER	Extremely Toxic, Flammable or Corrosive Lethal dose: A taste to a teaspoon	Rat poison Mercury batteries Some pesticides and weed killers Paint thinner Drain opener Some oven cleaners
POISON	Highly Toxic	

*Robert E. Gosselin et al., Clinical Toxicology of Commercial Products, Baltimore: Williams and Wilkins, 1984, pp. 1-2.

Hazardous Substance Characteristics

Signal Word	Characteristics	Examples
Ignitable (Flammable)	Catches fire readily; explodes easily	Fuels Some cleaning fluids Some furniture polishes
Corrosive	Eats away what it touches	Battery acid Bathroom cleaners Pool chemicals
Reactive	Undergoes an unwanted reaction when exposed to other substances	Bleach Ammonia
Irritant	Causes soreness or inflammation	Ammonia
Toxic	Poisonous	Lead Mercury Pesticides

Washington State also identifies some hazardous wastes as persistent and some hazardous waste as carcinogenic. Persistent waste and materials such as pesticide DDT last a long time in the environment. Carcinogenic waste and materials such as chlordane are cancer causing. The signal word, Irritant, is not part of the official terminology used by most government bodies.

Safer Subs

Subjects: Science, Home Economics, Consumer Education

Grades: 5-10

Teaching Time: One to Two Class Periods, Plus Extended Learning

Focus: Household Hazardous Products, Waste Reduction, Safer Substitutes, Consumer Awareness

Rationale

Hazardous household products, if improperly used and disposed of, may harm human health and the environment. Safer substitutes are available.

Learning Objective

Students will:

- Learn substitutes for common potentially hazardous household products.

Teacher Background

People have become concerned about the health and environmental effects of hazardous materials stored, used, or disposed of in their homes and communities. Consumers generally have little information about the long-term effects of chemicals contained in common home and garden products, or the proper management of these products once they are no longer needed. Many products and chemicals once considered “harmless” have now been linked to health problems due to exposure over long periods of time. These health effects can be as mild as fatigue and headaches or as serious as cancer.

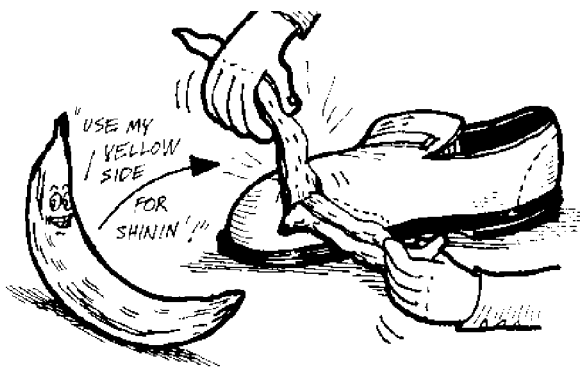
Many hazardous products people buy are not only potentially dangerous to human health and the environment but are often unnecessary and quite expensive. Alternatives to many potentially hazardous household products are available at

most grocery stores, and one alternative can often be used for several jobs.

Materials

Teacher Materials

- Magazine and newspaper advertisements for potentially hazardous products, such as drain cleaners, furniture polish, bug killer, etc. (Make sure the ads show at least some products with hazard warning labels.)
- Four or five examples of safer substitutes. (Optional) For example:
 - Banana peel as a substitute for a shoe shiner product
 - Vinegar as a substitute for window cleaner



- Salt as a substitute for coffee cup stain cleaner
- White chalk as a substitute for spot cleaners that remove oil stains
- Baking soda as a substitute for general household cleaners

See the sheet, “Potentially Hazardous Household Products - Some Safer Substitutes,” for other examples.

Student Materials

- Game cards, pp. 306-310. One set of cards for each group of four to five students. Cards will need to be copied and cut. Some cards are duplicates. This will not interfere with the

game's objective, which is to link a hazardous product with a safer substitute.

- "Potentially Hazardous Household Products - Some Safer Substitutes," p. 304. (One copy for each student)
- "Safer Subs - Alternatives for Potentially Hazardous Household Products," p. 305. (One copy for each student)

Pre & Post Test Questions

1. What are two reasons why safer substitutes for household hazardous products should be used?
2. What are two uses for baking soda?
3. Can you name one way to get rid of insects on plants?
4. What fruit can be used to shine shoes?

Learning Procedure

1 Hand out ads for potentially hazardous household products from magazines and newspapers. Make sure that each student has at least one ad.

2 Discuss with students how these products are advertised. **Ask:**

- Which of these products have you seen advertised on TV or heard about on the radio?
- What other similar products have you seen advertised? List responses on the board.
- What do the advertisers say these products will do for you? (For example, remove spots; kill bugs and germs, etc.)
- How do they try to convince you that their product is best? (e.g., new and improved; attractive packaging; the only one with enzyme action; easy to use; pleasant odor, etc.)
- Do the advertisers mention any potential hazards to human health and the environment?

3 Ask: "Why do people need these products?" "What purposes or function do they serve?" (Possible answers: to get rid of odors, to keep bugs from damaging plants or getting into food, to unclog drains, to stop fleas from bothering pets, to polish furniture, cars, etc.) List responses on the board.

4 Ask: "How do these products accomplish the purposes they serve?" (Possible answers: Cover up a bad odor with a sweet smell; kill bugs and fleas; dissolve or break down substances, etc.) Write down student responses on the board.

Ask: "Is there any other way to accomplish our purpose?" "Do we have to use these products?"

5 Explain that many of the potentially hazardous products people buy are not only unnecessary but may damage the environment and are often quite expensive. The packaging and advertising of a product is eventually paid for by the consumer. Safer substitutes are available at most grocery stores, and one safer substitute can often be used for several jobs.

6 Pass out the "Potentially Hazardous Household Products - Safer Substitutes" sheet. Read aloud. If possible, display some of these substitutes as you read about their uses.

Ask: "Are any of these substitutes used in your home already?" "Do your grandparents use any of these products?" "Do you think your family would be willing to use these substitutes? Why or why not?"

7 Explain to the class that they are now going to play a card game to help them identify safer substitutes for potentially hazardous household products. (Teacher: This game is similar to the card game, Go Fish.) Distribute the handout, "Safer Subs - Alternatives for Potentially Hazardous Household Products." Tell students that they will use the two lists to help them play the game.

Object of the game:

Students will try to make pairs of cards by matching a Hazardous Product card (marked HP) with a corresponding Safer Substitute card (marked SS). Students may refer to the Safer Substitute lists to make a correct match.

How to Play:

- Divide the class into groups of either four or five.
- Distribute a set of cards for each group.
- The Dealer passes out six cards to each player and himself. The remaining cards are placed face down on the table and become the DRAW pile. Play starts with the person to the left of the dealer. The person whose turn it is, is called the “Shopper.”
- Each player attempts to make as many matches as possible while “Shopping” (i.e., during his or her turn). Remember a pair is a Hazardous Product (HP) card matched with an appropriate Safer Substitute(SS) card as shown on the lists. During a turn, the Shopper is allowed to “Go Shopping” for as many times as matches can be made. “Going Shopping” means the player may ask another player (by name) for a specific SS or HP card that will make a match with a card in the player’s hand. Players must give up a card if asked. If the “Shopping Trip” fails (i.e., the player asked does not have the requested card), the “Shopper” takes a card from the DRAW pile. Shoppers may use their lists to determine what cards to “Go Shop” for.
- If a match is made, the Shopper lays it face up on the table in front of him or her, while stating out loud what the match is. Any other player may challenge a match, and an incorrect match will cause the turn to be passed immediately to the next player. The Shopper may continue to “Go Shop” as long as matches are made. Each time a “Shopping Trip” is successful, the two players draw a replacement card from the DRAW pile. The Shopper may also use this card to make a match. When no more matches can be made, then the player to the left becomes the new Shopper.
- When the teacher calls time (15 to 20 minutes) or the DRAW pile is used up, the player with the most matches is declared the winner. The winner in each group gets to demonstrate a safer substitute. (Optional)

8 Disband the groups and ask the demonstrators to report to class the results of using the safer substitute. Have the class question the demonstrators as to the effectiveness of the substitute. Discuss what the advantages and disadvantages are of using less or nonhazardous substitutes. Discuss how easy it would be to use safer subs at home.

Extended Learning

1 Create a slogan or poster warning against the use of potentially hazardous household products. (The Puget Sound Water Quality Authority’s “Don’t Pollute My Food” poster, displayed around Puget Sound, was designed by students.)

Acknowledgment: Adapted from Toxics in My Home? You Bet! Golden Empire Health Planning Center. Sacramento, CA .,1984.

Bibliography

Galvin, David and Sally Toteff. “Toxics on the Home Front” Sierra. September-October 1986, Vol. 71, No. 5, pp. 44-48.

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Potentially Hazardous Household Products - Some Safer Substitutes

For This Potentially

Hazardous Product

Try This Safer Substitute

Air Freshener _____	Cinnamon and cloves (simmered)
Bathtub and tile cleaner _____	Baking soda; vinegar and water
Burn mark remover _____	Grated onion
Coffee cup stain cleaner _____	Salt (moist)
Decal remover _____	Vinegar (soak in white vinegar)
Drain cleaner _____	Plunger; baking soda and hot water; vinegar and hot water
Furniture polish _____	Lemon oil (or juice) and mineral oil
General household cleaner _____	Baking soda
Hand cleaner for paint/grease _____	Baby oil
Ink spot remover _____	Cream of tartar and lemon juice and cold water
Insects (on plants) repellent _____	Soap and water
Moth repellent _____	Proper storage and laundering of clothing
Oil based paint _____	Water based paint
Oil stain remover _____	White chalk (rubbed into stain before laundering)
Paintbrush softener _____	Vinegar (hot)
Refrigerator odor remover _____	Baking soda
Roach repellent _____	Roach trap or "hotel"
Rug cleaner _____	Club soda
Rust remover _____	Lemon juice and salt and sunlight
Shoe polish _____	Banana peel
Slug repellent _____	Diatomaceous earth
Spot remover _____	Club soda; lemon juice; salt
Water mark remover _____	Toothpaste
Window cleaner _____	Vinegar (in warm water)
Wine stain remover _____	Salt

Handle with care even when using less hazardous household products!

Safer Subs - Alternatives for Potentially Hazardous Household Products

Use This Safer Substitute	For this Potentially Hazardous Product
Baby oil _____	Hand cleaner for paint/grease
Baking soda _____	Bathtub/tile cleanser; refrigerator deodorizer; general household cleaner
Banana peel _____	Shoe polish
Cinnamon and cloves _____	Air freshener
Club soda _____	Rug cleaner; spot remover
Cream of tartar and lemon juice _____	Ink spot remover
Diatomaceous earth _____	Slug repellent
Grated onion _____	Burn mark remover
Lemon juice and salt and sunlight _____	Rust remover
Lemon oil and mineral oil _____	Furniture polish
Plunger _____	Drain cleaner
Proper storage and laundering of clothing _____	Moth repellent
Roach trap or "hotel" _____	Roach repellent
Salt _____	Coffee cup stain cleaner; spot remover; decal remover
Soap and water _____	Remove insects on plants
Toothpaste _____	Water mark remover
Vinegar _____	Bathtub/tile cleanser; drain cleaner; paintbrush softener; window cleaner; decal remover
Water based paint _____	Oil based paint
White chalk _____	Oil stain remover

SS BAKING SODA; VINEGAR AND WATER SS	SS GRATED ONION SS	SS SALT (MOIST) SS
SS WHITE VINEGAR SS	SS PLUNGER; BAKING SODA AND HOT WATER; VINEGAR AND HOT WATER SS	SS LEMON OIL (OR JUICE) AND MINERAL OIL SS
SS BAKING SODA SS	SS BABY OIL SS	SS CREAM OF TARTAR AND LEMON JUICE AND COLD WATER SS



<p>HP</p> <p>PAINT BRUSH SOFTENER</p> <p>HP</p>	<p>HP</p> <p>INK SPOT REMOVER</p> <p>HP</p>	<p>HP</p> <p>HAND CLEANSER FOR PAINT/GREASE</p> <p>HP</p>
<p>HP</p> <p>GENERAL HOUSEHOLD CLEANER</p> <p>HP</p>	<p>HP</p> <p>FURNITURE POLISH</p> <p>HP</p>	<p>HP</p> <p>DRAIN CLEANER</p> <p>HP</p>
<p>HP</p> <p>AIR FRESHENER</p> <p>HP</p>	<p>HP</p> <p>BATHTUB AND TILE CLEANER</p> <p>HP</p>	<p>HP</p> <p>BURN MARK REMOVER</p> <p>HP</p>



<p>HP</p> <p>REFRIGERATOR ODOR REMOVER</p> <p>HP</p>	<p>HP</p> <p>SHOE POLISH</p> <p>HP</p>	<p>HP</p> <p>RUST REMOVER</p> <p>HP</p>
<p>HP</p> <p>MOTH REPELLENT</p> <p>HP</p>	<p>HP</p> <p>OIL BASED PAINT</p> <p>HP</p>	<p>HP</p> <p>OIL STAIN REMOVER</p> <p>HP</p>
<p>HP</p> <p>RUG CLEANER</p> <p>HP</p>	<p>HP</p> <p>ROACH REPELLENT</p> <p>HP</p>	<p>HP</p> <p>INSECTS ON PLANTS</p> <p>HP</p>



<div>HP</div> <div>COFFEE CUP STAIN CLEANER</div> <div>HP</div>	<div>HP</div> <div>DECAL REMOVER</div> <div>HP</div>	<div>HP</div> <div>SLUG REPELLENT</div> <div>HP</div>
<div>HP</div> <div>SPOT REMOVER</div> <div>HP</div>	<div>HP</div> <div>WATER MARK REMOVER</div> <div>HP</div>	<div>HP</div> <div>WINDOW CLEANER</div> <div>HP</div>
<div>HP</div> <div>WINE STAIN REMOVER</div> <div>HP</div>	<div>HP</div> <div>CINNAMON AND CLOVES (SIMMERED)</div> <div>HP</div>	<div></div>



Hazards In My Home?

Subjects: Science, Health, Home Economics, Industrial Arts, Consumer Education

Grades: 6-9

Teaching Time: One to Two Class Periods

Focus: Household Hazardous Waste, Hazard Warnings, Hazardous Substance Characteristics

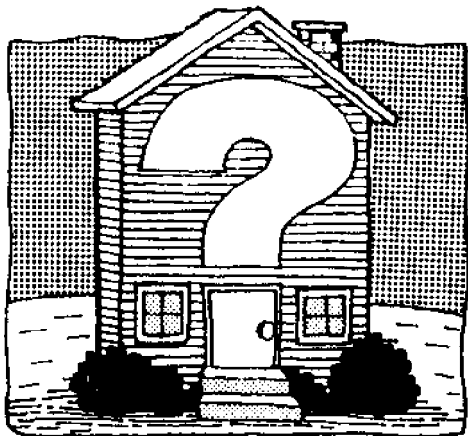
Rationale

Many common household products are hazardous. Using and disposing of such products safely requires a knowledge of the different identifying characteristics of hazardous substances.

Learning Objective

Students will:

- Learn the basic characteristics that identify materials and wastes as hazardous:
 - Ignitable (or flammable)
 - Corrosive (or irritant)
 - Reactive (or irritant)
 - Toxic (or poisonous)
- Identify commonly used household products that are hazardous to human and/or animal



health and the environment if not used and disposed of safely.

Teacher Background

People have become concerned about the health effects of hazardous materials stored, used, or disposed of in their houses and communities. Consumers generally have little information about the long-term effects of chemicals contained in common home and garden products and are unfamiliar with the information provided on the label. Many products and chemicals that were once considered "harmless" have now been linked to health problems, due to exposure over long periods. These health effects can be as mild as fatigue and headaches or as serious as cancer. Often products act synergistically (the action of two or more substances, organs, or organisms to achieve an effect of which each is individually incapable) with other substances in the environment, particularly air pollutants.

In the past, hazardous substances have been characterized and labeled in a variety of ways. Even now, there is no completely consistent characterization scheme that is used by all government regulations. The Household Hazardous Waste Wheel appearing in this activity uses the word "Irritant," which is not a part of the legal definitions used by Washington State to describe and label products. Substances that are irritants could be either "Corrosive" or "Reactive," or both. However, for the purposes of this activity, reactive and irritant can mean the same thing.

Similarly, the words "Ignitable" and "Flammable" are often used interchangeably, although depending on the locale, they may or may not have different chemical and/or legal meanings. Although this is a bit confusing, it very much reflects the reality of household hazardous substances and their labeling as it exists today.

Materials

Student Materials

- Five Household Hazardous Waste Wheels (See Resources)
- “Inventory of Potentially Hazardous Household Products” (Use the forms on pp. 314.)

Teacher Materials

- Overheads: “Hazardous Substance Warnings,” p. 297, and “Hazardous Substance Characteristics,” p. 299.
- Examples of hazardous household substances: drain cleaners, insect foggers, polishes. Make sure the containers are empty. (Do not empty container just for this activity.) Bring the label, or tape lids shut and wrap the entire container in a clear plastic bag and tie the top.

Pre & Post Test Questions

1. What are two potentially hazardous products that could be found in each of the following areas of your home?

- Bathroom (toilet bowl cleaner, certain household cleansers, laundry soaps)
- Kitchen (furniture polishes, oven cleaner)
- Garage/basement (pesticides, flea powders, paints)

2. What are four characteristics that identify a material as hazardous? What are the hazards that these products have? Can a product have more than one hazard?

3. What are three “warning” words for hazardous substances?

Learning Procedure

First Day

1 List the “Pre & Post Test Questions” on the board. Have students brainstorm answers to these questions. Write down student responses to these questions.

2 Show the overhead “Hazardous Substance Characteristics.” Discuss what qualities makes

something hazardous. (Harmful to human or animal health; harmful to the environment) **Ask:** “What is waste?” (Something not needed anymore, or an unwanted by-product from the manufacture of an item)

3 Show the overhead “Hazardous Substance Warnings.” **Ask:** “What makes some substances more dangerous than others?” (The amount required to cause harm and how hazardous it is.)

4 Break the class up into five groups. Give each group a Household Hazardous Waste Wheel. Using the wheel, tell the groups to prepare a report for class presentation. Assign each group three products from the list generated in Step 1. Each report should cover:

- The hazard characteristics
- The type of product (automotive, household, etc.)
- The proper disposal choice (recycle, use up, etc.) Since the wheel is designed for nationwide use, you may want to give specific disposal options in your county.
- A safer substitute

Have each group give their report.

5 Distribute the “Inventory of Potentially Hazardous Household Products.” Tell students they will use this form to find out what hazardous products they have in their homes and how these products are labeled to warn the consumer. This can be given as an overnight or longer assignment. Stress that these products are potentially hazardous and that caution should be taken while doing the inventory. Tell the students to ask their parents for assistance. Have students make sure items are labeled correctly and are on shelves out of children’s reach. Put *Mr. Yuk* stickers on. You may find parents that do not want their children doing the hazardous product inventory. A signature space has been provided on the inventory for parents to indicate they do not wish to have their child participate.

6 Important. Discuss and make sure students understand the provisions of the warnings on the first page of the “Inventory of Potentially Hazardous Household Products.” Using the example products you bring to class, show how to fill out the inventory.

Second Day

Discuss some or all of the following questions after the students have completed and turned in their surveys. You may wish to prepare a tally sheet that combines all the results (pp. 317). Students whose parents requested they not do the inventory can tally combined results and present them to the class.

- Which items were found most frequently?
- Where were most of the products found?
- What are the best places to store potentially hazardous products? Did you find any products being stored unsafely?
- What was the most common warning on the labels? Did similar products have similar warnings?

- Which products had directions for safe disposal?
- Did any of the products mention the health effects that the product could have?
- Were any products found that did not have adequate warnings, or that were unlabeled?

Extended Learning

- 1** Using the Household Hazardous Waste Wheel, have students fill out the alternatives section of the inventory.
- 2** Show the video Household Hazardous Wastes: A Little Goes A Long Way. (See Resources)
- 3** Write an article for the school or community newspaper about some common household hazardous materials. Describe the warnings, some alternatives, and safe disposal practices.
- 4** Prepare safety sheets and post them in your home where hazardous materials are stored.

Resources

Household Hazardous Waste Wheel. Environmental Hazards Management Institute, 1991. (Five per classroom).

Video Tape: Household Hazardous Waste: a Little Goes A Long Way. Washington State Department of Ecology. 1987. 18 min., color. (Available for loan)

Check your local health department for materials specific to your area.

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Ontario Waste Management Corporation. Hazardous Waste Education Resource Kit. Toronto, 1985.

Robertson, David K., et al. “Liquid Household Hazardous Wastes in the United States: Identification, Disposal, and Management Plan.” Environmental Management. 1988, Vol. 11, No. 6, pp. 735-742.

Inventory of Potentially Hazardous Household Products

This activity is an inventory. You are going to hunt around your house, basement, and garage to find out which of these products you have. Ask your parents to assist you with this activity.

Caution: Do not disturb or spill these products. Some of them might be harmful. Wash your hands carefully after you handle any container that might be leaking. (Not all household products are hazardous.)

1. Check off items you find. Add others that you find that are not on the list.
2. Write down where you find the product (under sink in kitchen, etc.). List both the room and exact location.
3. Read the labels of the products. Write down any warnings (hazards and characteristics) that are on the labels. Have parents collect unwanted items for collection day.

Do you have?	Where is it stored?	Warnings	Hazard Characteristics	Alternative (Do In Class)
HOUSE				
___ Oven cleaner				
___ Drain cleaner				
___ Toilet cleaner				
___ Disinfectants				
___ Rug or upholstery cleaners				
___ Floor or furniture polish				
___ Bleach or cleaners with bleach				
___ Photographic chemicals				

_____ *Please excuse my child from doing the inventory*

Do you have?	Where is it stored?	Warnings	Hazard Characteristics	Alternative (Do In Class)
___ Silver polish				
___ Pool chemicals				
___ Mothballs				
___ Powder or abrasive cleaners				
___ Ammonia or cleaners with ammonia				
___ Spot removers				
PAINTS				
___ Enamel or oil based paints				
___ Latex or water based paints				
___ Rust paint				
___ Thinners and turpentine				
___ Furniture strippers				
___ Stain or finish				
AUTO				
___ Antifreeze				
___ Used oil				

Do you have?	Where is it stored?	Warnings	Hazard Characteristics	Alternative (Do In Class)
___ Brake fluid				
___ Transmission fluid				
___ Batteries				
___ Gasoline				
PESTICIDES				
___ Herbicides (weed killers)				
___ Rat and mouse poison				
___ Roach and ant killer				
___ Flea collars and sprays				
___ House plant insecticides				
___ Fungicides				
___ Slug bait				
___ Other garden pesticides				
OTHER				

Tally Sheet - Household Hazardous Products

Product	Warning Label			Hazard Characteristic				
Type	Caution	Warning	Danger	Ignitable	Corrosive	Reactive	Toxic	Other
AUTOMOTIVE								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								
HOUSEHOLD								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								
PESTICIDES								
1.								
2.								
3.								
4.								
5.								
6.								
7. Others								

Tally Sheet - Household Hazardous Products

Product Type	Warning Label			Hazard Characteristic					
	Caution	Warning	Danger	Ignitable	Corrosive	Reactive	Toxic	Other	

PAINTS

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

OTHERS

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

MISCELLANEOUS

Hazardous Substance Toxicity Chart

Warning Word	Toxicity*	Examples
CAUTION OR WARNING	Moderately to very Toxic Lethal dose: A teaspoon to a pint	Ammonia Most paints Floor polishes Antifreeze Bleach Some fertilizers Many pesticides
DANGER	Extremely Toxic, Flammable or Corrosive Lethal dose: A taste to a teaspoon	Rat poison Mercury batteries Some pesticides and weed killers Paint thinner Drain opener Some oven cleaners
POISON	Highly Toxic	

*Robert E. Gosselin et al., Clinical Toxicology of Commercial Products, Baltimore: Williams and Wilkins, 1984, pp. 1-2.

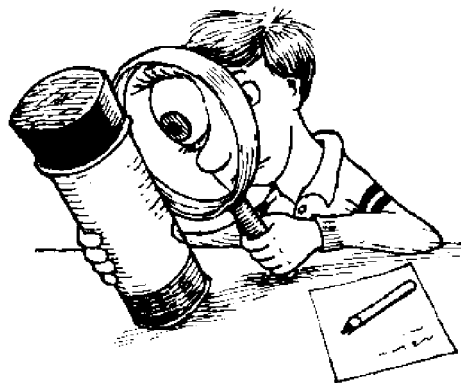
Read The Label

Subjects: Science, Health, Social Studies, Home Economics

Grades: 7 - 10

Teaching Time: Two Class Periods and One Homework Assignment

Focus: Household Hazardous Products



Rationale

Some of the most common and frequently used household products contain hazardous chemicals. Using and disposing of such products wisely begins with knowing which products pose a problem - by reading labels.

Learning Objective

Students will:

- Understand that the same substances that make a product useful can also make that product potentially hazardous.
- Understand that labels on household products contain important information on how to use, store, and dispose of products safely.

Teacher Background

People have become concerned about the health effects of hazardous materials stored, used, or disposed of in their homes and communities. Consumers generally have little information about the long-term effects of chemicals contained in common home and garden products. Many products and chemicals once considered "harmless" have now been linked to health problems, due to exposure over long periods. These health effects can be as mild as fatigue and headaches or as serious as cancer. Often products combine with other substances in the environment, creating a reaction which is more hazardous than the individual chemical's effects.

A substance that is classified as hazardous is required to bear labeling with warning statements and safety information if it is packaged for, or intended for, use in or around the home. The U.S. Consumer Product Safety Commission has established specific labeling requirements; however, labels required for various hazardous substances differ. This, in addition to the considerable amount of label information required, can make it very difficult to determine how to use, store, and dispose of a product safely.

Materials

Examples of

- Potentially hazardous household products such as drain opener, spray oven cleaner, paint, car care products, scented liquid furniture polish, aerosol air freshener, or pesticides. Make sure the containers are empty. (Do not empty container just for this activity.) Bring the label, or tape lids shut and wrap the entire container in a clear plastic bag and tie the top.

Student Handouts

- "What's In Your House?" pp. 324
- "Read the Label - Product Worksheet"
- "Household Hazardous Products Test" (Optional)

Teacher Overheads

- “Hazardous Substance Toxicity Chart” (p. 319)
- “Hazardous Substance Characteristics” (p. 299)

Pre & Post Test Questions

See the handout “Household Hazardous Products Test.”

Learning Procedure

Day One

1 Ask: “What does the word “toxic” mean?”

(poisonous) Hold up a container of liquid drain opener or garden pesticide. **Ask:** “Is this toxic?” “What’s the safest way to find out?” (Read the label)

“What other household products might be toxic or hazardous?”

“What does hazardous mean?” “What qualities would make something hazardous?”

“How does the label on a product give us information on potential hazards?”

2 Show the overhead, “Hazardous Substance Characteristics,” p. 299. Explain to the students that the characteristics on the overhead are used to describe hazardous waste and that additional terms such as “generates pressure” are required on product labels. Using different hazardous household products as examples, identify the other characteristics of hazardous materials. (corrosive, reactive, ignitable) Circulate the household products (safely prepared) and ask students to discuss which hazardous properties each product has. **Ask:** “Do any products have more than one kind of hazard?” “Are there any words on the label that you do not know the meaning of?”

3 Tell students that many people are unaware that such common products may be hazardous. Consequently, these products are often used or disposed of unsafely. The same substances that make a product a good cleaner or solvent by dissolving dirt, grease, or other unwanted solids can also act

to dissolve your skin or the surface of your lungs, etc.

Tell students that poisonings can occur not only by eating or drinking but also by breathing and skin absorption.

Tell students that direct or prolonged exposure to hazardous materials may damage human health in a variety of ways. Depending on individual sensitivity, a person may develop a headache, experience nausea or lightheadedness, or have difficulty breathing. Many other symptoms are also possible.

Some hazardous materials are associated with long-term effects that may not be noticeable for years - for example cancer, birth defects, or gene mutation. Chronic health effects are not usually on warning labels and are often unknown.

4 Ask: “What on a product’s label tells us that the product may be hazardous?” “What key words should we look for?”

Show the overhead “Hazardous Substance Toxicity Chart,” p. 319. Tell students that these words apply mostly to the degree of toxicity of the substance, but that they may also refer to how serious the consequences of mishandling are. Review the key words with students. Ask the students to think of a memory aid (mnemonic) to help them remember the order of toxicity.

- CAUTION OR WARNING - Use the product with care; low to high toxicity.
- DANGER - Signals that exposure or unsafe use may cause injury, illness, or death; high or extreme toxicity.

5 Distribute copies of the five-page handout “What’s In Your House,” pp. 324. Allowing 15 to 20 minutes, have students read and complete the five worksheets. The worksheets deal with:

- Drain openers/oven cleaners
- Furniture polish
- Air fresheners
- Pesticides
- Solvents

Discuss and review student responses.

6 Homework Assignment. Distribute two copies of the “Read The Label” worksheet p. 328, to each student. Have students examine, in their home, labels from at least two products with hazardous properties. Tell students to fill out worksheets and prepare to participate in classroom discussion about their findings.

Day Two

Start the discussion with the following items:

1. Necessary Precautions: Some of the precautions that products had. Did the labels mention any health hazard from prolonged use?
2. Warning Symbols: What, if any, warning symbols were used? Were the warning symbols clear?
3. First Aid Measures: What kind of first aid measures were printed on the labels? Were the instructions clear?
4. Ingredients: What are “active ingredients”? (The ingredients that make the product both useful and potentially harmful.) What are “inert ingredients”? (Substances that “carry” the active ingredient and are also potentially harmful.) What are the amounts of the different kinds of ingredients? Why are some amounts larger than others? (Active ingredients are present in small amounts due

to their potency.) Does the label list what the inert ingredients are? Why is it important to know the names of chemicals? (To be able to tell a doctor or other health professional the kind of poison, etc.)

5. Directions for Use, Storage, and Disposal: What were some of the precautions listed in the directions for use? Did the label give any suggestions for storage? For disposal?
6. Ask your class, working in small groups, to design and create labels for hazardous materials of their choice. To get them started, ask:
 - What information should a hazardous product label list?
 - How should the information be displayed?

Extended Learning

- 1 Find out if your city or county government has a poison information center. Call the Department of Ecology Recycle Hotline, 1-800-RECYCLE, about a specific chemical substance listed on a product.
- 2 Have students present to the class hazardous material labels they created.

Acknowledgment

Parts of this activity were adapted from Toxics In My Home? You Bet!: Curriculum on Household Toxics for Grades 7-8. Golden Empire Health Planning Center, Sacramento, CA, 1982. .

Resources

“Household Hazardous Waste Wheel.” Environmental Hazards Management Institute. 1987.

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Mother Earth News, staff. “Mother’s Guide to Hazardous Household Substances.” Henderson, N.C.: Mother Earth News Foundation. May-June 1984, No. 87, p. 54.

Schwartz, Anne. “Poisons In Your Home: A Disposal Dilemma.” Audubon. May 1987, Vol. 89, No. 3, pp. 12-16.

What's In Your House?



Drain Openers - often contain a substance called sodium hydroxide. Another name for this is lye. It is very corrosive to body tissue and can cause burns. The degree of the burn depends on the amount of chemical exposure and the person's sensitivity to it. Drain openers are designed to eat away the materials clogging your drain. The material is generally made of organic matter—much like your skin. They should be used with extreme care. To avoid the release of toxic fumes, drain openers should never be mixed with another brand or with bleach. Most accidents involve children with burns of the mouth, face, esophagus, and upper digestive pathways.

Oven Cleaners - most oven cleaners contain lye, much like drain openers. Some oven cleaners are in aerosol spray form. Aerosol sprays are particularly dangerous because the very fine mist spreads over a large area of the room and can land on skin, eyes, and sensitive lung tissue. While skin can regenerate itself, this is not true of the lungs.

What type of signal words and/or other precautions do you think should be listed on these products? Give your reasons.



Furniture Polish - may contain pretty scents and colors that are attractive to children who can be seriously injured by drinking them. Polishes come in different forms, and different chemicals are used to help apply the polish onto the furniture.



Some kerosene-like substances are present in some polishes. When ingested, they enter the lungs and saturate them so that the lungs cannot function. There is no way to rid the body of the poison or to reverse its effect.

The health dangers most often occurring with furniture polishes are from ingestion and inhalation of fumes—especially from the aerosols. The aerosol spray propellants may decompose to harmful gases when in contact with a heated surface.

Another common danger is the polish getting into sensitive parts of the body, especially the eyes.

Most polishes are flammable and can ignite when applied by someone who is smoking.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Air Fresheners - usually act in one of three ways: (1) masking or counteracting one odor with another; (2) coating the nasal passages with an oily film; or (3) diminishing the sense of smell with a nerve-deadening agent. Tampering with our sense of smell can be dangerous because olfaction (smelling) is one of our best human defenses against fire, toxic gases, and decayed or spoiled foods.

Many air “fresheners” simply contaminate the air with another foreign substance and have no freshening effect at all.

Some of the chemicals found in aerosol air fresheners can be extremely dangerous to internal tissues and organs.

Aerosols can become powerful bombs when exposed to heat, external pressure, or puncture. They are also a major source of air pollution in the home, particularly when used in small closed rooms such as the bathroom.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.





Pesticides - are poisons. Some of them remain in the environment for long periods and resist natural means of breakdown and decomposition. Some are formulated to rapidly breakdown. Some pesticides may destroy beneficial as well as harmful insects and can also harm plants, birds, fish, squirrels, and other wildlife.

Chemical pesticides are a convenient way to get rid of or control unwanted insects or other pests, small mammals, weeds, or fungus growths. Convenience, however, comes at a high price. The price was realized by an 8 1/2 month old infant who had been suffering from a cough for a few weeks and then died five days after her room had been sprayed by an exterminator.

In California alone, it is estimated that each year about 14,000 incidents of pesticide exposure result in requests for medical assistance. Most of these are nonoccupational exposures involving children in the home or garden.

Pesticides can injure the user if consumed, absorbed through the skin, or inhaled. Pesticide poisoning often resembles, and is mistaken for, the flu. Symptoms may include headaches, nausea, dizziness, aches, etc. Some pesticides have also been associated with more damaging effects such as cancer or birth defects.

Authorities believe that many pesticides (over 50 percent) have not been adequately tested for their ability to cause cancer or birth defects.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Solvents - are substances that dissolve other substances. The most familiar and universal of solvents is water. Water dissolves minerals and carries them in sap to the upper reaches of plants. In cooking, it dissolves sugar and salt. Nonwater-based solvents are called organic solvents—so called because chemicals like them (i.e., those based on carbon) form the structure of living things. Most solvents are organic and capable of causing injury if not used properly.

Some solvents enter the body through skin contact because they dissolve oily materials (skin oils, for instance) so easily. Inhalation can have an irritant effect on mucous membrane and can cause nausea, headaches, muscular weakness, drowsiness, and impaired motor response (leading to a loss of coordination that contributes to increased accidents). One of the prime organ targets of solvents is the liver—the organ that removes poisonous chemicals from the body and aids in food digestion. The liver can be severely damaged by solvents that destroy liver cells. One symptom of liver disease is jaundice—a yellowing of the skin and eyes.



The eyes are a major target area of solvents. People who refuse to wear goggles place themselves at risk of injury when handling solvents. Solvents can be splashed or reach the eyes by scratching an itch or pushing away some hair. This is especially dangerous if the victim is wearing soft contact lenses, which can absorb the chemicals and hold them against the eyes until the lenses are removed. The length of exposure can cause considerable eye damage or irritation.

Solvents dry easily but the vapors still linger in the air and are breathed unless there is plenty of fresh air and good ventilation.

What type of signal word and/or other precautions do you think should be listed on this product? Give your reasons.

Name _____
Product _____

Class _____

Read The Label - Product Worksheet

Directions: Tell your parents about your assignment and ask for their assistance. Carefully read the label on the container and answer the following questions:

1. What is the name of the product?
2. What are its uses?
3. What are its active ingredients? Give their percentages, if any.
4. What are the product's inactive or inert ingredients? Give their percentages.
5. Does this product have any hazard or warning word or symbol? If so, what is it and what does it mean?
6. List any directions that help protect people's health.
7. Does this label offer any first-aid directions? If so, what are they?
8. Briefly describe, from the label, directions for use and directions for storage.
9. Describe, from the label, directions for container disposal.
10. What other helpful information is listed on the label?
11. What information do you think should be on the label that is not there?
12. Would you buy and use this product again? Give reasons?
13. Does this product have any environmental warnings? If so, what are they? Could your disposal choice be a threat to the environment?

Household Hazardous Products Test

1. List the four basic characteristics of hazardous substances.
2. Give three examples of potentially hazardous household products.
3. List three signal words that indicate a product's level of hazard, in the order of toxicity from lowest to highest.
4. Give two reasons why people buy potentially hazardous household products.
5. Give the name and health effect of one chemical found in a home or garden product.
6. Identify two ways potentially hazardous household products can be used unsafely.
7. List three unsafe disposal methods for household hazardous wastes.
8. Name two organizations that may be able to give you information on sensible disposal of potentially hazardous household products.
9. List two potentially hazardous household products and their safer substitutes.

TRUE OR FALSE

10. ____ Toxic means poisonous.
11. ____ Poisonings occur only through eating or drinking harmful substances.
12. ____ Some pesticides destroy beneficial as well as harmful insects.
13. ____ Putting household wastes down a storm drain is a good idea because storm drains are connected to sewage treatment plants.
14. ____ Used motor oil can be recycled.
15. ____ Solvents can pass through the skin and be absorbed in the bloodstream.

What Goes Around Comes Around

Subjects: Science, Social Studies

Grades: 7-12

Time: Three or Four Class Periods

Focus: Household Hazardous Waste, Ground Water Quality, Bioaccumulation, Ecology, Persistent Chemicals, Impermeable, Aquifers, Microlayers, Sewage Treatment, Sludge, Leachate

Rationale

Household hazardous wastes, if improperly disposed of, threaten public health and the environment.

Learning Objective

Students will:

- Understand the environmental consequences, particularly the effects on water, of a variety of household hazardous waste disposal methods.
- Learn where persistent household hazardous wastes go when they are thrown out.

Teacher Background

Hazardous substances can enter our environment in a wide variety of ways. Because the subject is so large, this activity is primarily informational in nature.

Refer to the Glossary for definitions of any unfamiliar terms.

Materials

Teacher/Classroom Materials

- Examples of commonly used household hazardous products, such as motor oil, a garden pesticide, or paint thinner
- Protective gloves (optional)
- Brochure [Protecting Our Ground Water](#) (see Bibliography)

- Overheads "Routes To The Environment" (p. 342) and "Bioaccumulation" (p. 341)

Student Handouts

- "Where Will It End Up" worksheet
- Disposal option information sheets (These sheets are on separate pages for easy distribution of a particular option.)

Pre & Post Test Questions

1. Why are persistent hazardous substances of particular concern in waste management?
2. What is bioaccumulation?
3. What are four different hazardous waste disposal options? (Give an example of a product that should be disposed of using each option.)
4. How can we reduce the amount of household hazardous waste we produce?

Learning Procedure

1 Bring to class one or two examples of some common types of household or school hazardous substances. Motor oil, pesticides, and paint thinner are good examples of products that are known to be persistent and long lasting in the environment. Handle these products with care. As a precaution, notify the school and/or parent if you intend to bring these products to class. You may wish to bring empty containers only. Restrict student handling of these products. Wearing gloves for protection will emphasize the hazardous nature of these products.

2 Explain that some combinations of hazardous chemicals degrade (break down) quickly into safe, naturally occurring substances. Explain that in this activity we are primarily concerned with persistent hazardous chemical combinations - those that remain unchanged in the environment for long periods, or chemicals that combine with natural substances in such a way as to pose a hazard to humans and other living organisms. Show the

overhead “Bioaccumulation” and discuss the concept with students.

3 Ask: “What should we do with these products when we are through with them?” “What are the different ways we might dispose of them?” (Recycle, flush down the drain, put in the garbage can, burn in the back yard, pour out on the ground or pavement.)

Tell students that some disposal options are no longer legally available, but for the purposes of this activity, we will want to think about what happens to substances when they are disposed of in various ways.

Discuss with students any directions for disposal that the labels on the products give. For example, most motor oil containers suggest recycling.

4 Discuss with students that part of the study of ecology is the examination and understanding of connections. Tell students that the class will now consider how each of the possible ways we might use to dispose of household hazardous waste could be connected to our food and water supplies.

5 Tell students they are now going to consider where wastes go. Show the overhead “Routes To The Environment” and display/distribute the pamphlet Protecting Our Ground Water. Point out to the class the various ways a chemical can travel through the environment from our homes.

6 Divide the students into groups or pairs and assign a different disposal method to each group.

- Incineration
- Storm drain, ditch, hole in the ground
- Sink/toilet
- Garbage can
- Household hazardous waste community collection

Have each group brainstorm for several minutes on where substances disposed of by their designated disposal method might end up. You may wish to assign a different hazardous product to each group. Questions that each group can ask themselves are:

- If we dispose of the product by this method, what might happen?
- Is there any way that wildlife might be harmed?
- Is there any way this product could get into our drinking water?
- Is there any way this product could get into our food?

Tell the groups to consult the brochure Protecting Our Ground Water and use the “Where Will It End Up” chart to write down their ideas.

7 Have the groups share their ideas with the rest of the class. After each group presents its ideas, discuss with the class the information contained in disposal option sheets that are included with this activity. You may wish to pass these out to the class. If you prefer, do a different disposal option each day. Ask the class to vote on the best disposal choice for each product. Show the video Household Hazardous Waste: A Little Goes a Long Way. (See Resources)

8 After all the options have been covered, review with the class where persistent household hazardous waste goes. **Ask:** “What can we do to reduce the amount of household hazardous waste we produce, in other words eliminate or reduce the waste before it becomes a problem for us and the environment?” Have students brainstorm ways that we can prevent persistent hazardous substances from harming the environment. Have them think of solutions they themselves might do, such as:

- Don’t buy products containing hazardous materials. Learn to read product labels. See the activity “Read The Label,” p. 321.
- Use safer substitutes. See the activity “Safer Subs,” p. 301.
- Use up what you have or, if it is not a banned chemical, find someone who can use it.
- Take it to a hazardous household waste collection program or a recycling center that handles hazardous substances.

Tell students that they can get information about participating in a collection program by calling their local health department or by calling the Department of Ecology's Recycling Hotline, 1-800-RECYCLE.

Extended Learning

Give the class some more examples of potentially hazardous household products (safely prepared) or use examples from the activity "Hazards In My Home?" on p. 311 and ask them to decide the best way to deal with each.

Acknowledgment

Much of the information in this activity is taken from the activity guide Sleuth: Educational Activities on the Disposal of Hazardous Waste, published by the Municipality of Metropolitan Seattle (Metro). We wish to thank Dave Galvin for his permission to use this excellent resource.

Resources

Household Hazardous Waste Wheel, Environmental Hazards Management Institute, 1991.

Video Tape: Household Hazardous Waste: A Little Goes a Long Way. Washington State Department of Ecology. 1987. 18 min., color.

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Product Disposal Recommendations

Incineration

If you burn your household hazardous wastes, what happens? This depends on the type of chemical in the waste being burned. A pressurized aerosol can could explode and cause injury. Burning paints could leave a residue of heavy metals which is toxic. Burning rags soaked with cleaning fluid might simply vaporize the liquid into the air. This would disperse it and thus make its concentration very low.

Burning plastic containers or certain solvents could release potentially harmful fumes like hydrogen cyanide or chlorine bearing compounds that are harmful if inhaled. Some of the chlorine bearing compounds do not break down easily and last a long time. Over a period of time, these compounds can accumulate to levels that are harmful to the atmosphere.

Burning household hazardous waste is illegal in a homeowner's woodstove, burning barrel or fireplace. It is also illegal to burn garbage, plastic,

rubber products, paint, waste petroleum products, or painted or treated wood.

In addition, the burning of household hazardous substances by individuals is never complete. This means that waste is illegal if small particles from paper or cloth are released into the air. These particles, which can carry toxic substances, may settle and form a very thin layer called a microlayer on different surfaces, such as plant leaves. The toxic substances in the layers can interfere with vital biological processes. Microlayers can also form on the surface of water. Because microlayers form at the place called an interface (where two different states of matter meet such as liquid and gas or solid and liquid) it is much more likely that toxic substances will become concentrated in these microlayers.

Finally, human beings can breathe small particles into their lungs and absorb the toxic substances into the bloodstream. (Our lungs are an interface with the atmosphere).

Storm Drain, Ditch, Hole in the Ground

If you pour household hazardous waste in a storm drain, in a ditch, or in a hole in your backyard, there's a good chance the waste will end up in a nearby stream, river, or lake. Let's figure out exactly where your waste might go.

First, the storm drain—The square metal grates at the sides or curbs of streets are called storm drains or catch basins. When it begins to rain, the first drops soak into the ground, but once the soil is saturated or if it's covered by cement, the rain runs into these storm drains. They drain anything soluble on your driveway, backyard, or street into the storm sewer system.

Once there, this runoff water enters pipes which carry it to larger pipes or "trunk lines" buried under the ground. These pipes empty the water into the nearest drywell or waterway: a creek, river, or lake. So if you pour used motor oil down the storm drain in the street in front of your house, it very well may end up on the feathers of ducks or the gills of fish in a nearby lake.

In some areas, the storm drain joins sanitary sewer pipes and the runoff water goes to a sewage treatment plant. This is called a combined sewer system. In this case, the water containing your hazardous waste will be treated. Some sewage plants have only a single treatment stage which will not eliminate most hazardous wastes. Other sewage plants have secondary treatment plants that eliminate many more, but not all, hazardous wastes.

However, these are very expensive. What kind of systems do you have in your city?

Next, the ditch or your backyard—In some areas there are no storm drains. Once the soil is saturated, rainwater runs overland to the nearest ditch or gully and downhill to the nearest waterway. If you disposed of a household hazardous waste - say a pesticide - in your backyard or applied it on your yard, and it rained hard the next day, the rain would carry the substance overland along the ditches to a waterway or down into the ground water.

"Ground water," "water table," "aquifer," "artesian well," and "springs" are names which describe where water is and what water does underground. Water drains or soaks into the ground until it hits an impermeable (difficult to penetrate) layer. The water then collects in the spaces between sand, gravel, or rock particles. Underground areas where ground water collects are called aquifers. Some aquifers replenish lakes or streams. Others are enclosed by layers of rock and do not move. Wells are drilled into both kinds of aquifers, those that flow and those like pockets. Aquifers around the country are becoming contaminated at an alarming rate, threatening drinking water supplies.

Of all the water available in our state, only a small amount is actually available for drinking purposes. From where does your drinking water come?

Sink/Toilet

When you pour the substance down the sink or flush it down the toilet, where does it go? It goes either to the municipal sewage treatment system or into a septic system.

The sewage system is a network of underground pipes that collect liquid waste from each house, store, office, factory, and building and bring it together into huge pipes called trunk lines. These trunk lines carry enormous volumes of waste.

Not all that long ago, sewage used to be dumped directly into rivers, lakes, sounds, and oceans. What problems did this create?

Now, most cities and towns have municipal sewage treatment plants to clean up sewage before it is pumped into Puget Sound or a nearby river.

At the sewage treatment plant, the water is treated with chlorine or ultraviolet light to kill any disease-causing organisms in the raw sewage. Much of the solid material and some of the heavy metals are also removed by allowing them to settle out of solution. Common heavy metals are lead, zinc, mercury, and cadmium. Exposure to heavy metals, in any other amount than small concentrations, can be harmful to human and environmental health.

Some of the toxics in the sewage biodegrade, while others, including some of the heavy metals, settle out in a residue called sludge. Sludge is sometimes disposed of in a landfill but is usually applied as a fertilizer to forest land. Some hazardous chemicals can be absorbed by plants, and these plants, in turn, are eaten by animals and the chemicals can accumulate and concentrate to dangerous levels. This process is called bioaccumulation. The Environmental Protection Agency has set standards for the level of toxicants in sludge that may be used on farm or garden soils producing food. As a substance moves from one organism to another, through being eaten or absorption, the substance is

said to move through a food chain. Each link in the chain may accumulate the hazardous substance in higher concentrations. Human beings are often at the top of a food chain, which means the food we eat has had a chance to bioaccumulate many times.

If you poured a persistent hazardous waste down the sink, which food chains could these hazards become part of?

Today, we are only starting to recognize and understand the environmental damage caused by household hazardous waste. There is no doubt that treatment removes or makes less harmful some of the toxic substances found in sewage. Some hazards, however, are not removed and are pumped into rivers and into Puget Sound.

If your house is not connected to a sewer system, it is probably connected to a septic tank. Many gallons of water and sewage go through these septic systems each day. (For example, most toilets use five to seven gallons for every flush.)

Bacteria break down much of the waste entering a septic system. However, if you pour or flush hazardous waste into a septic system, the waste can kill this helpful bacteria and can contaminate the septic tank sludge or septic system's drain field soil. The sludge, pumped every four or five years from the septic tank, is disposed of either at a sewage treatment plant in a septage lagoon or in a sludge landfill (basically a hole in the ground). The septic system can last many years if the sludge tank is pumped out periodically. If the system is not pumped regularly, the bacterial action may stop, allowing harmful substances into the ground water; or the drain field may get blocked, causing the system to back up.

The suspected cancer-causing chemical trichloroethylene (a powerful solvent and degreaser) has leached from septic tank drain fields in several places in the country to contaminate local wells.

This compound, used in the past as a cleaner for septic tanks, is the suspected source.¹ Chlorinated compounds make good cleaning agents, but they are persistent, toxic, and mobile. Bacteria that can break down nonchlorinated substances cannot biodegrade these compounds, which pass through such systems into the drain field and ultimately may end up in drinking water sources.

1 Metro Toxicant Program Report No. 1E, Water Quality Division, Seattle, 1982.

Garbage Can

For many people, after they put their trash in the garbage can, they probably don't think about it any more. The garbage truck comes by every week and takes it away. But now that you've been studying garbage, maybe you'll think about it more.

What happens to your garbage after it's picked up? Where does it go?

In some areas, the garbage truck takes your trash to a transfer station. From there, it is hauled by large trucks to a landfill.

What happens to garbage after it reaches the landfill? What happens to hazardous waste if you put it in the garbage?

Trash in landfills used to be burned to reduce the volume. This produced a relatively nontoxic ash, but sent hazardous emissions into the air.

Consequently, open burning was stopped and replaced by compaction and burial of waste. The waste at a landfill is heavily compacted. As a result,

almost any container will break and its contents spill. Now the problem is leachate.

At the landfill, rainwater and any liquids in the waste soak through the garbage. Soluble (dissolvable in water) hazardous materials may be washed down with them. This liquid mixture is called leachate. Leachate will go down through the soil until it reaches an impermeable layer (a layer it cannot go through), or it will flow downhill over the surface. Leachate can contaminate ground water and surface waters. Landfills constructed today must have a protective lining, a leachate collection system, and a ground water monitoring system. However, many of our existing landfills were established prior to these requirements.

So if you throw household hazardous waste in the garbage can, the waste's persistent components may end up in the soil, groundwater or surface water near your local landfill.

Household Hazardous Waste Collection

Many counties in the state of Washington now sponsor household hazardous waste collection programs or permanent, staffed collection sites. Spokane and Island counties, as do other counties, rely almost exclusively on ground water for all county water needs and are particularly concerned about safely collecting household hazardous wastes in order to keep them out of local landfills and out of drinking water.

During a county collection program, people can bring in, generally at no cost, household hazardous materials. In cooperation with private hazardous waste management companies, county workers record and pack hazardous waste in drums for shipment.

Some of the material can eventually be rendered safe by hazardous waste management companies using various chemical, physical, and/or biological techniques. Some can be recycled (e.g., motor oil and solvent). Some must be shipped, at a high cost, out of state for disposal in a hazardous waste landfill or high temperature incinerator. Washington State currently has no hazardous waste landfill or incinerator.

If you participate in a county program and take your household hazardous waste to a collection site, your waste will be safely handled. It will be transported for treatment, long-term storage, or disposal in an out-of-state hazardous waste landfill or incinerator.

Where Will It End Up Household Hazardous Waste Disposal Choices

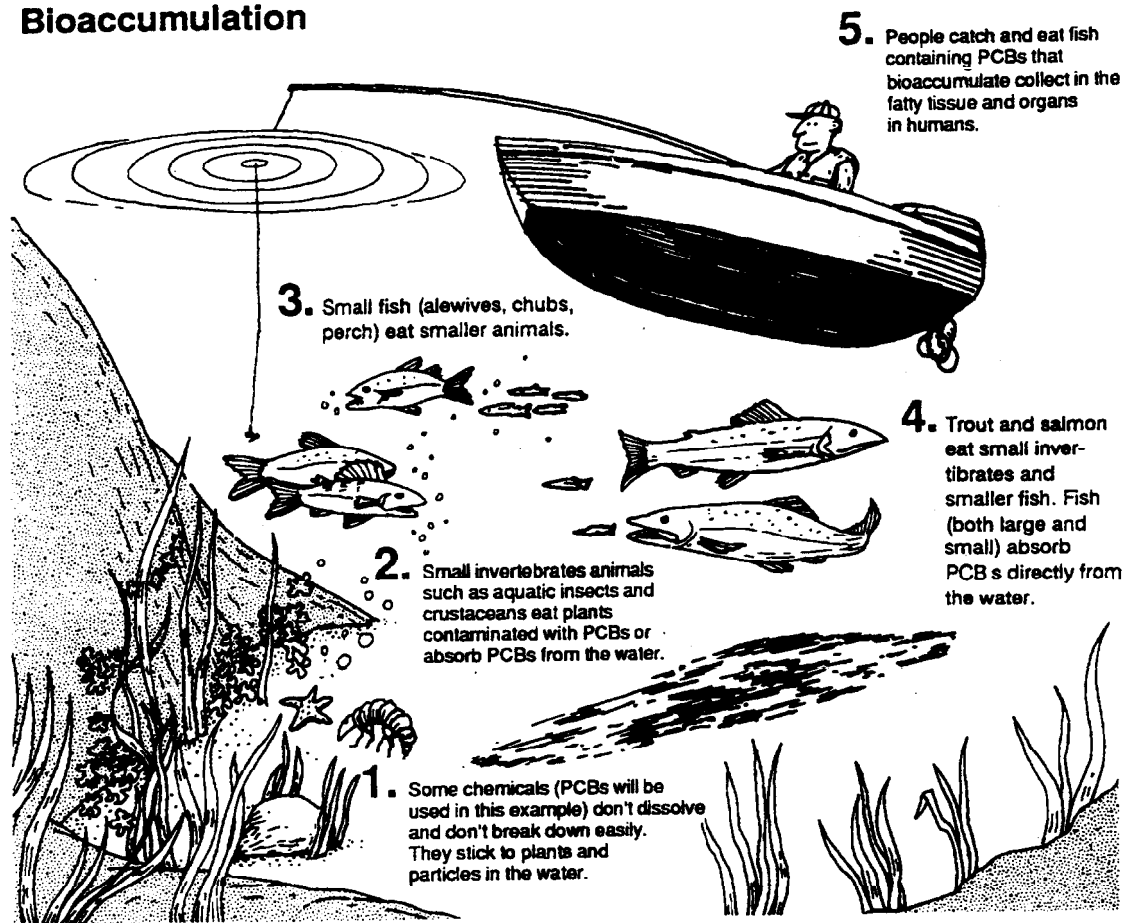
*Incineration, Storm Drain/Ditch/Hole in Ground, Sink/Toilet, Garbage Can, Household
Hazardous Waste Community Collection*

Disposal Choice _____

Product	Air	Water	Wildlife	Land	Other
1. Paint Thinner					
2. Motor Oil					
3. Weed Killers					
4. Aerosols					
5.					
6.					

List as many possibilities as you can. If the disposal option can lead to pollution in the water, say what kinds of water (streams, ground water, etc.).

Bioaccumulation



Routes To The Environment

